No. 3081

United States Circuit Court of Appeals

For the Ninth Circuit

MINERALS SEPARATION, LTD., ET AL,

Appellees,

vs.

BUTTE & SUPERIOR MINING COMPANY,

Appellant.

Transcript of Record

Volume 8

(Pages 4213 to 4888, Inclusive)

UPON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MONTANA

McKee Ptg. Co., Butte, Mont.

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bubble; though it is more easily observed over a level surface of water in a pan.

Q. 31. I call your attention to another portion of this same answer of Professor Beach's as follows: "The physical phenomenon which happens there is a spreading or adsorption of the oil over the interface, and I have no question that there is a layer of adsorbed oil upon the interface of that bubble just as here we find that when the experiment was completed we have an oiled layer or adsorption film in the upper figure." What have you to say as to that testimony?

A. Except for the uncertainty that there may exist with regard to the thickness of the layer, I do not question it. It confirms the general statement in the first part of conclusion No. 3 as to what happens when the oil comes in contact with such an interface. The oil spreads over and modifies its characteristics. But, insofar as that may be taken to mean a hundredth of an inch or a foot, I wouldn't call that an adsorption layer because it is not my idea of an adsorption film.

Q. 32. Professor Beach in answer to question 256 said, referring to the lecture by Lord Kelvin, "in that lecture he has carried out a calculation to show what the least thickness might be. The upper limit, the maximum thickness there one can hardly state. If you put on a large drop of oil, a ~~and~~ certain amount~~s~~ of it spreads over the surface and the rest of it gathers together in a little lens-shape figure, and if you add more oil the lens increases its diameter, until the whole surface would finally become covered to any depth." What have you to say as to that testimony?

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A. That again confirms the same part of conclusion 3, with the comments that these results were largely based on calculations or theory rather than on direct measurements as I remember them. But there are later results that are extremely accurate and they very closely confirm the original calculations, defining however more clearly the lower limit of complete filming, the upper limit of complete filming without lenses, and then the slightly higher limit of forming of a stable film with lenses. Either one of these films would probably be greater as the—either one of these films would probably be regarded as an adsorption film if one wanted to call it that and use the word in that sense, but that the lens of oil or globules of oil sticking up on the surface of that film and exhibiting the properties of oil in mass should be confused with the adsorption layer seems to me unwise, would lead to incorrect conclusions as to the action of that oil.

Q. 33. I call your attention to Q. 138 and the answer in the testimony of Professor Beach, and read the following question: "My opinion is that this angle would be smaller than in the case of pure water against a sulphide, and that the lifting power of this bubble would be diminished." I call your attention to that question and answer for explanation and comment?

A. I do not feel altogether like accepting the statement with regard to the angle as being a sufficient basis for a conclusion as to lifting power. There is a closely qualitative relation apparent between the two

P. 4215, L. 3, insert "early in my examination of this phenomena I was fortunate" after "but"

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and I think one might use that as perhaps as a general guide, but enough to see some manuscript pages of a book that was started out to be written on the subject of contact angles, and there came to be such a wide divergence between the contact angles under different circumstances (what way the particle was moving and its shape and so on) that the author introduced "hysteresis of contact" into the equation ~~question~~ to try to explain the phenomena and finally did not publish the book. I think that is fairly well illustrated by the statements that were made with regard to the wetting of glass by mercury. If the glass bubble, to which I think it was Professor Beach referred, be brought down to the surface of the mercury and a tiny particle of glass be floated on the surface of the mercury, according to the movement of that glass the particle floating on the surface will be either rapidly pushed away from the point of contact or drawn to the point of contact, just as we can see the aluminum particles floating on the surface of the glass drawn to or pushed away from anything that bends the surface down or pulls the surface up. Now, when it pulls the surface up we have one contact angle; when it bends the surface down the consequence is that we have a different contact angle and I am inclined to agree with Professor Bancroft when he says that he does not regard contact angles as accurately measurable. In fact in his mind there was some question whether there was any such thing; but insofar as the contact angle is an accurate measure of what is going on, I entirely agree with Professor

Beach's conclusion as to its effect on the lifting power. In fact, that confirms the latter portion of conclusion 3 where we saw that with this modification of the contact, ~~of~~ the air-water surface tension is reduced to a moderate extent, ~~and~~ The ring experiment which has been spoken of, the floating ring greased with one kind of material or another, confirms the balance of the statement, "varying with the oil and the conditions," and I would think we will find indirectly implied in the existence of anything like a reduc~~ing~~ed contact angle, the confirmation of the statement that further reduction of the surface tension is relatively small.

Q. 34. I quote the following from the answer of Professor Beach to question 164: "The surface tension of a liquid film, that is, with an upper and lower surface, a liquid film does not depend on the thickness as long as that thickness exceeds a certain small value." What have you to say as to that?

A. That confirms the proposition of conclusion 3, "after a certain minute quantity of oil is present, further reduction of the surface tension is relatively small."

Q. 35. Continuing in answer to question 164 Professor Beach says: "Do you want that thickness? Q. 165. Yes." And then follows this statement: "I can only quote from memory as I haven't my notes with me. I have represented here (drawing a diagram on paper) a molecule of any substance, and here is another molecule of the same substance. Then, the limit of molecular range, I mean the greatest distance which

we can separate these molecules and still have this one act upon that, that distance 'd' is, I believe, one twenty thousandths of a millimeter." What comment have you to make as to that testimony?

A. That would seem to me to confirm one of the facts essential to my statement that there might be action between the air and a mineral even though minutely oiled. That appears to be a statement of the limiting thickness of a layer of oil which will interfere with that interaction, and that as being approximately two millionths of an inch, which we spoke of this morning as being the length of action of materials, one on the other. Since the thickness of the oil layer is less than that you might expect to have direct action between air and the mineral particles. If, according to the assumption made by Professor Beach, there were an admixture of air and oil at the surface and oil and mineral at the other surface, I don't think these layers of admixture are anything like the same thickness and so I don't think they make much difference.

I read the following testimony of Professor Beach, Q. 174: "I would like a definite statement from you as to whether or not the affinity of air for metal is utilized in the froth flotation concentration of ore. A. In the agitation froth process, or in the pneumatic froth process it is not. It is not, except in as far as there may be air adsorption in this interface. 175-Q. That is, there may be air adsorbed at the oil adsorption interface? A. There may be air adsorbed at any place where air is in contact with another liquid or an-

other solid, but in my judgment air plays a relatively insignificant part." What have you to say as to that testimony?

A. First, that it indicates the presence in Professor Beach's consideration of precisely the same conceptions of direct action between the air and the mineral that may be effective with very minute layers of oil. But, more important than that ~~this~~, it seems to me to indicate that he has in mind (when he is speaking of air froth flotation) a thin film of oil, of such thickness that it cannot be called a layer, but would exhibit the properties of a film and of such thickness that the difference of surfaces on the inside and the outside of the layer might very well be effective on the property of the layer, if you call it a layer. I should prefer to call it a film. It is in substantial agreement, it seems to me, with the latter portion of conclusion 3.

Q. 36. I call your attention to question 63 in the testimony of Professor Taggart, that question having been propounded by the court, it being as follows: "You say the particles are in the film of oil surrounding the air" and particularly to the part of the answer, "And there can be no question ~~statement~~ of the attachment of air for the particle itself," and further on below: "By examining these froths it can be seen that air is not in contact with the solid particles at all and they come to the surface in the bubble film." What have you to comment as to that testimony?

A. In the first place I think Professor Taggart was speaking of the film which he had made with a

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considerable quantity of oil. If I recollect properly he testified that he had not observed films made with extremely minute amounts of oil and I want to call attention to the fact that the film which he showed us contained at least twice as much liquid as the film of a bubble because by taking a whole bubble, as I understand that he did and puncturing one side of it to break it, the liquid from the bubble would draw together into the single film that was left at the bottom, the solid particles being left rather in contact with the ring so that in observing such a film we would be looking at twice the amount of liquid, without twice the amount of solid material, and we would expect it to be very much more wetted. That, however, is minor because the statement as a whole I think fully confirms my conclusion that even with the oily mineral frothing agent in minute quantities or in considerably large quantities the attachment of the mineral is direct to the bubble in the sense that the bubble is made up not merely of a piece of air but of the dynamic film; the film that surrounds the bubble and that the particles in the layer, in this film, are attached to this film directly. It confirms the statement of direct contact.

Q. 37. Professor Taggart has testified in answer to question 61 as to his examination of bubble films under the microscope: "In such examination I have found that in freshly formed films a very large majority—and by that I mean in the proportion of ten, or twenty, or thirty, or forty thousand to one—of the particles present in the film, are entirely within the

bubble film." What have you to say as to that testimony?

A. That these bubble films if made in the way that the other one was made, would have a great deal more film material but that this would not be an important difference because the major effect of the statement is, after all, merely to state that the mineral particles under these circumstances are directly attached to the films of which the bubbles are made. They are directly attached to the bubbles.

Q. 38. I read to you the following from the testimony of Professor Bancroft, 140 Q. "In your judgment would it be proper to call such a froth an air froth, meaning thereby that the air is attached directly to the mineral particles? A. It would not be proper to call it that, because that is not what happens; and it is a great deal better, it seems to me, to stick to the facts." What have you to say as to that testimony?

A. That we have not been concerned mainly with the necessarily direct attachment of the air to mineral, which is the only basis on which that criticism could properly be made. If we consider that the real essential of the conclusion is the attachment of mineral to the bubble, I don't think Prof. Bancroft would have made that criticism. His other testimony all confirms the opinion that, taking the sense of "bubbles" in the broad, practical meaning, he would certainly regard the mineral as attached to those films; in fact he called them adsorbed into the film, in which case they must be attached to the bubbles. It is rather splitting hairs to divide the bubble from the air in the bubble.

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38' Now, the particular froth which he referred to is described in 139 Q., as made by agitation at about 1800 r.p.m. of 80 c.c. of water at 70°, 16 grams of Broken Hill tailings, and six c.c. of 20% sulphuric acid and one drop of oleic acid, which would be between one-tenth and two-tenths of a per cent of the ore, and as to that he was asked whether it would be proper to call it an air froth, and he said it would not. What have you to say as to that?

A. Well, in any reasonable interpretation of the expression, air froth, it certainly would be. Even in the precise scientific definition it would be a froth in which there was substantially nothing but air and mineral. In the most detailed and accurate scientific examination of the froth you would find something less than 1/100,000 of an inch of oil to be distributed on the surface of that mineral, and that, if any of the oil be assumed to go anywhere else at all, we would be down in the neighborhood of the ranges where the direct connection between the oil and mineral would be expected to have been at the admixture of the interface—at the adsorption of the interface. So it would be characteristic to call that air froth; it could be hardly called anything else.

Q. 39. I would here ask you what you have to say as to the statement of Prof. Beach, that air performs a relatively insigniifcant part in froth flotation, as well as the statement of Prof. Taggart along the same line?

A. That I can not agree with them at all, because

it is not merely a question of the buoyancy of the material. They have got nothing even remotely resembling the characteristic air froth, If they use some material which is not effective, like the air to catch the mineral particles in these minute layers of oil at an interface, between those layers, or within those very minute layers ~~the mineral particles~~. In other words, that in the absence of air and of a large predominance of air, there would be entrapment of the mineral in the oil instead of any effective attachment of the mineral to the air bubble.

Q. 40. Professor Beach, in answer to Q28 and referring to his experiment in a beaker with red ink and water and oil, referring to the interface, says: "The striking thing about this is its viscosity and possibly lower surface tension. This is the fabric of which the bubble film in the flotation process is made up." What have you to say as to that testimony?

A. That it again confirms the statement of direct attachment, and in view of what we have seen in the experiment, serves to mark off the difference between direct close attachment of the mineral to the bubble constituted of such a layer, as compared with the indirect, loose and ineffective attachment of the mineral to the bubble by a long neck or a considerable mass of oil. The force exhibited by such a layer is far more effective—incomparably more effective, I am tempted to say, than the cohesion by a mass of oil, if that be the only connection between the mineral and the bubble.

Q. 41. Professor Beach, in his answer to question 8, describing an experiment which I believe you have

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in mind, says: "The sulphide would be above the surface; it would be elevated by these little balloons, to ~~through~~ which they stick." I hand you the testimony in question and ask you for your comment thereupon.

A. In order for the bubble to carry the mineral above the surface, as we know that it does in the characteristic air froth, in making the characteristic air froth, it is to my mind essential that the mineral particle be attached directly to this film or layer, which, as Prof. Beach has said, really constitutes the bubble. However, these citations are substantial confirmations of the distinction between an oil froth and an air froth, and confirmation of the statement that the mineral in the air froths is directly attached to the bubbles.

Q. 42. I read you the following from the testimony of Prof. Bancroft, his answer to question 22: "When you add a practically insoluble oil to water, it is usually adsorbed by the water, and spreads out as a thin film; that this film gives you largely increased viscosity, as was shown the other day, and since this is a surface film which has more viscosity than the mass of the liquid, you will get foaming." What have you to say as to that testimony?

A. That seems to me ~~be~~ to point a distinction which I am inclined to draw between Van B mmelen's ~~[illegible]~~ original definition of adsorption, and the mere spreading of a layer of oil on the surface of the water. However, the general tenor of the answer is the result of drawing a distinction between soluble and insoluble oils. The action of insoluble oils—at least the insoluble portion of

the oil—being distinguished from the soluble portion. The statement that there is a largely increased viscosity, may apply, and in my opinion does apply to the true adsorption layer—and by that I mean the adsorption layer in the sense in which I have attempted to use it throughout the case—for the condensation line, rather than a layer of mixture. But that that viscosity is effective through any considerable distance outside of the film, or either side of the film, seems to be very well disproven by Prof. Taggart's experiments, when he added a small amount of oil to the surface of the liquid, and showed that rotation of the spider did not materially affect any movement of the floating chip; but as soon as a little dust was sprinkled on the surface, there seemed to be a connection between the chip and the spider. If the film had any substantial or any considerable viscosity—the film between oil and water—it seems to me it would have effected very much more movement of the chip. The movement there would perhaps be sufficient to—would perhaps be seen to take place in the oil above that film, without necessarily affecting any considerable area of the film as a whole. The statement, however, agrees, as far as I can judge it as definite—it agrees with my conception of what occurs when those extremely minute films go down and include a particle of mineral. The films, owing to their higher viscosity, give the direct attachment between the mineral and the bubble, and serve to prevent the minute particles of mineral moving about in the surface of the bubble, collecting at one side and

P. 4224, line 13, after "and" insert:
"floated his magnetis spider on the surface of the liquid and"

P. 4225, line 19, after "walls" insert: ", it can be made more stable by adding something or other which will increase the viscosity of the cell wall."

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getting away from the bubble by drawing down all of the oil to one side of the bubble mantle.

As far as the statement of foaming is concerned, it seems to be simply a confirmation of the conclusion we have given as conclusion No. 4, that "the presence of oily mineral frothing agents in the bubble or in the water, also modifies the water, in the sense that the subdivision of the air is rendered easier, and coalesence of the bubbles is retarded." In order to have the formation of that foaming I think it is necessary to make the subdivision of the air easier than is the case with pure water, and to retard, if not wholly prevent, the coalesence of those bubbles, once formed.

Q. 43. I call your attention to Q. 39, and the answer in the testimony of Prof. Bancroft, as follows: "How can a froth be made more stable? A. Since the instability of the froth is due to the low viscosity of the cell walls or of the films constituting the cell walls." What have you to say as to that testimony?

A. The film constituting the cell walls is another way of speaking of direct attachment to the bubble. Clearly what is in that film is in the bubble. But, broadly speaking, the statement is again a confirmation of the conclusion that the oil, acting as a mineral frothing agent, modifying the action of the bubbles, makes it possible to produce a froth.

Q. 44. Now, I would like you to do an experiment if you will, using an air bubble in an all oil medium, and observe the different lifting power upon small mineral particles.

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A. I have here one of the glass cells, which contains some pine oil, and, as was the case before, we will endeavor to make clear the connection between air surfaces and mineral, in the presence of considerable amounts of oil, in this case using a large quantity of oil, half filling the cell, and putting mineral into the oil, allowing it to rest on the bottom of the cell and approaching it with the bubble, to see what happens.

Again we will take the minus 200 mesh mineral, which, as can easily be seen from the soiling of the paper, contains dust of almost infinitesimal size, and we will place some of that with forceps at the bottom of the cell half full of oil. Some of it drops off the forceps before the forceps touch the surface, and extremely fine illustration of just what I want to emphasize occurs. The mineral goes to the bottom. The air leaves the mineral and goes back up to the top. The air could not adhere to the mineral under those conditions. Putting a bunch of the minerals, enclosed in the ends of the forceps, at the bottom of the cell, and opening the forceps and raising them, we see that substantially no air was left inclosed in that mineral by the time it got to the bottom of the cell; another clear indication of the rapidity with which oil slides in between mineral and air; and if there is a sufficient amount of oil to separate them, beyond their range of co-operation, and in an interaction, there is a complete divorce of the air and mineral. In order to enable us to observe a little more clearly both the inside and the outside of the bubble, I have used what might be called

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a sectional bubble holder, that is, a bubble holder which has on one side a piece of ten-thousandths inch microscopic cover glass, welded into the side of the bubble holder, to give a flat face and to enable us to bring the bubble directly against the side of the cell. Taking such a bubble in the pine oil with which the cell is half filled, and approaching the mineral resting on the bottom, you can observe through either side of the cell that there is apparently no gray surface or no indication of contact between the air and the mineral; in other words, that looking through two optically plane surfaces, the air comes in contact with an oil layer resting on the mineral, but does not succeed in taking up the mineral at all. We may agitate it there as I am doing now for some time, and then raise the bubble, bringing the bubble over to the side of the cell, and I think you will observe that there is no evidence whatever of any mineral attached to the bubble; that ~~the~~ if the bubble is looked at underneath, a beautifully clear and pellucid surface is seen, to which not the slightest partice of this mineral is attached.

Q. 45. That is to say, under these conditions even the finest particles of metalliferous mineral can not be attracted or held by an air bubble; is that the statement of what you have demonstrated?

A. It is.

Q. 46. BY THE COURT: Did the air touch the mineral?

A. The air touched the mineral as far as we could touch it, as far as air is capable of touching mineral in the presence of excess oil.

Q. 47. BY MR. WILLIAMS: Did you press the air bubble down on to the mineral?

A. It was pressed down on to the mineral repeatedly, again and again. Had the mineral been in water, there would have been an instantaneous gathering of that same mineral on the surface of the bubble, as can of course be easily seen in another vessel, using the same mineral and any kind of bubble holder. It is somewhat difficult to get such fine mineral to go through the air-water interface; in fact very little of it has gone down to the bottom.

Q. 48. MR. SHERIDAN: You did not put it down with the forceps?

THE WITNESS: No, but I will be delighted to do that, because it makes no difference how the mineral gets to the bottom. We did that before, and we found the air very unwilling to leave it; so much so, that the mineral would not separate from the forcep ends, and you see, it is difficult to put the mineral in there; that is precisely what you saw before, and your attention was called, when we finally did get the mineral to fall off, that it was not held as a point, but what might be called a bubble full of mineral; and when that is approached with a bubble holder full of air, we find that there is a very great readiness of that bubble to take up the mineral. Spreading the mineral out somewhat on the bottom where you can get it, and blowing aside the mineral that has collected to some extent on the surface, we produce a bubble which is substantially clear of mineral, and we go down upon the finely di-

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vided mineral, picking up first an aluminum particle which is lying in the vicinity, and at the same time picking up quite an aggregation of fine mineral, galena particles, that are present on the bottom.

Whereupon further hearing was adjourned until Wednesday morning, May 9th, at 10 o'clock a. m.

Wednesday, May 9th, 1917, 10 a. m.

DR. GROSVENOR,

DIRECT EXAMINATION Resumed
BY MR. WILLIAMS:

Q. 49. You have stated your conclusions as to air froth flotation, and I have called your attention to certain parts of the testimony of the scientific experts for the defendant. I wish you would continue upon that subject without direct interrogatories, giving your views and any explanations of that testimony, in a continuous answer.

A. Conclusion No. 5, given yesterday, as to the action of the mineral frothing agents, in coating the mineral bubbles and producing the frothing action will be found confirmed in Dr. Taggart's testimony, page 915, question 199. He puts it that acetic acid has the same selectivity for mineral—for metal, because, as he reasons it, it must have if the sulphide particle concentrates at the surface of the air bubble in a way similar to the way in which it concentrates at the surface of the air bubble when oil is used.

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Also Professor Bancroft, question 131, page 1118; but in my opinion (expressed in the conclusion) there is a difference not recognized in Prof. Taggart's statement, which Prof. Bancroft does recognize. "The oil layer you have is ~~this~~ different, because it does not come out as oil ~~in~~ you, have a relatively oil rich solution in contact with the air ~~surface~~ throughout, ~~but~~ and you do not have any contact between the solid particles and the air." That is a denial, apparently of the misunderstanding that there has been claimed all the time, direct contact of necessity between the air and the mineral, rather than between the bubble and the mineral. This is the contact with the bubble which I regard as existing.

Professor Bancroft, page 1055, question 18, speaks of the surface film which is more viscous than the mass of the liquid, but the absolute viscosity is very low; and then he proceeds to explain on page 1048, (Q9) the relation between frothing and this viscosity. As further confirmation by Professor Bancroft as to the contention of our statement in regard to the action of soluble mineral froth ing agents, he goes into details on pages 1050, 1051 and 1052, Q12-14 and the explanation to a greater extent on 1049, 1050, and 1051 Q11-13—(that is the method in which he conceives it was carried out) but the general description of the action is entirely confirmatory of the conclusion. All through his testimony we find again and again repeated, so many times that it did not seem desirable to take it up and emphasize it in each case, the direct attachment, provided the understanding be that the attachment is with the bubble and not necessarily with the gaseous filling.

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Professor Bancroft also partly recognizes on page 1119, question 132, the possibility of air entering into the oil film, and mineral entering into the oil film to the extent of the adsorption film on each side, which would make it quite conceivable at any rate that there should be an action between the air within the bubble and the mineral hanging on the surface of it.

THE COURT: These bubbles you made yesterday were in distilled water?

A. Some of them were and some of them were in modified water.

Q. 50. How do you describe the bubbles there as distinguished from the air? You speak of the mineral attaching to the bubble but not to the air.

A. The bubbles in any common understanding of it, any ordinary understanding of it, and in my opinion in the most accurate explanation of it, would not be the mere mass of air present within a film, but would be the combined whole, a filling of air in a sack of films; because the air by itself unless enclosed in a film would not be for the purpose of our work a bubble at all.

Q. 51. THE COURT: But in the water you distinguish a film there, distinguished from the water?

A. In pure water?

Q. 52. Yes, what you had yesterday?

A. I think so without any question. A great mass of the testimony of the other experts is that at the junction between the air and the water there is at least one film. In my opinion there are ~~only~~ two. There is

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a film of highly dense water on the outside which does not behave physically as the ordinary mass of water does and there is a film of highly condensed air on the inside which does not behave in every respect as ordinary free air does. In other words, there is in a sense there also a double film; but where I have referred to the double layer before I have been speaking of a layer on the two sides of the minute oil film. Perhaps I should say the interface on the two sides of the minute oil film. There again we have an interface which does not act quite like the ordinary oil in bulk, and on the outside, between the oil and the water we have another interface which does not act like either oil or water. Both of them have properties peculiar to matter tha I think we depend for all these phenomena involved.

Confirmation of conclusion 6 (without entering into just precisely what processes ad I think that will be involved in the reading) will be found in Professor Beach's testimony, page 970, question, 39, Professor Bancroft's testimony, page 1101, line 4 (Q117) That is also interesting as a confirmation of this direct attachment to the layer, because he speaks of his solid adsorbed by the oil layer, by the oil-water interface or by the oil-rich solution. In other words, he agrees entirely with Professors Beach and Taggart in putting the mineral particle which is carried by the pulp, into that layer which is an essential part of the bubble. The portion of the conclusion of yesterday which affects the modification will be confirmed by Prof. Beach's testimony, page 1007, question 138, where it is recognized that

P. 4232, line 15, after "matter" insert: "in film, and it is on this peculiar condition of matter"

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Prof. Beach regards the contact angle as expressive of that change of condition which we call modification, change in the action between two materials. A similar confirmation is found on pages 994 to 997, (X Qs 109, 110) particularly page 997. (X Q 110) Further confirmation of a part of the conclusion referring to action of excess oil, that is excess oil above the minimum amount, the action tending to take up these mineral particles and stabilize, what we call armour the bubbles, is found in Prof. Beach's testimony, page 959, line 18, (Q 20) and 961 and 962, (Qs 20-23) and also in Prof. Taggart's testimony, page 924, question 244, where he states that he regards the presence of the solid matter as far the most important part of the process of stabilizing. The particular portion of the conclusion to which this chiefly refers is the latter half. "Th~~is~~ese film ~~again has~~ give a controlled affinity"—by "controlled" we mean modified or restrained or aided; and by "affinity" we mean as defined, the tendency to get together and stay together—"of air bubbles for metallic particles in the presence of a frothing agent, and if given opportunity produce~~s~~ the stable froth of so-called armoured bubbles." The next conclusion with regard to the action of oil above the necessary quantity and approaching that quantity which separates the layers, and perhaps if carried on separates them to the point of injuring the attachment, will be found—such confirmation will be found in the testimony of Prof. Beach page 1043, line 10, (R x Q 256) where he describes the formation of lenses; and the testimony of Prof. Taggart where he describes his film that he saw under the mi-

croscope, particularly when it is remembered (as pointed out yesterday) that he had about twice as much liquid on one side of the bubble, because in puncturing the one side of the bubble the liquid moved around to the other side and remained. That incident is an extremely good confirmation, as was pointed out yesterday, of the direct attachment, the action of the oil neck, where the amount of oil in the film becomes too great, ~~is~~ a well confirmed by Prof. Bancroft, page 1108, question 118, and page 1110, (Q 119) at the bottom of the page: "Since the thick film of oil—I am using "thick" without giving any definite limit to the size for a moment ~~a film that is thick under those conditions~~ is not ~~so~~ stable, and consequently the oil will pull off—" and by the use of "film" I think Professor Bancroft was choosing his words well—"not extremely thick layer" but "a film that is thick under those conditions is not ~~so~~ stable and consequently the oil will pull off." On page 1110, question 119, Prof. Bancroft says again: "The air bubble will tend to pick up the oil globule (in the pulp), and the oil or some of the oil will pass around ~~to~~ in the interface between ~~the~~ water and air." Under the influence of gravity it will not tend to concentrate uniformly, but distinctly it will not be uniform, "and you will get more of the oil down at the lower end of the bubble;" and since a thick film is not ~~so~~ stable, "oil will pull off and you will have your air bubble with a thi~~ck~~n film of oil around it and the rest of your globule of oil will be drifting around wherever fate ~~will~~ may take it."

Further confirmation of that weakness of attach-

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ment will be found in Professor Bancroft's testimony, page 1109, question 118; also page 1112, question 122, where, in criticising the statement that the mineral was attached directly to the air as he understood it, he says: "I should prefer to draw the conclusion * * * * that the cohesion between oil and oil was less than the adhesion between ~~air~~ oil and ~~oil~~ air." In other words, in my own language, the bubble ~~uses~~ has, ~~when~~ attached to an adsorption layer of oil, a cohesion layer of oil, and the mineral, ~~when~~ is attached to an adsorption layer of oil on the other side—more properly film ~~it~~ should be used in the first and last cases.

Now, according to Professor Bancroft, if a strain is put on that, we have nothing but the weak cohesion of the oil between those two weak layers to hold the thing together.

Confirmation of conclusion seven will be found further in an indirect way in Professor Beach's testimony, page 1024, question 192: "Q. And the more oil you put in, the better the results, is that right? A. You will ultimately arrive at bulk oil flotation. You would not have any bubbles if you put in oil enough." The statement in regard to bubbles is interesting, in view of what we saw yesterday in the way in which the air bubble leaves mineral in the presence of a quantity of oil: I speak of quantity as distinguished from a film.

Further confirmations of the conclusions offered yesterday will be found in respect to conclusion No. 9, where Prof. Bancroft speaks of kerosene being

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a non-frothing oil; in other words, inert in at least one respect, page 1057, question 51; question 24; page 1066 question 50; all of these are in regard to the action of kerosene. He further says, bearing on this question of the quantity of oil which attaches the mineral to the air bubble: "Consequently the kind and nature and amount of ~~air ratios~~ aeration'" as I get it from the record—"will play a very large factor in determining what ratio of oil ~~and~~ to mineral you can use safely." Not what is necessary.' That seems to have been the thought—the thought throughout the testimony seems to have been how much you crowd on without doing damage. That is found on page 1108 (Q118) ~~at the bottom.~~

Now, in regard to the action of the air bubble, that was very clearly shown yesterday in bubbling a continuous stream of air under water over the oil, practically until all the oil was removed by the bubbles down to the point where the particle would not only lift by the captive bubble, but would lift by the free moving bubble. Prof. Bancroft says, page 1110: "Again the air bubble will tend to pick up the oil." The same quotation was used before, but it has a somewhat different bearing here, bearing on the question of the de-oiling of the bubble; question 119. The other has a somewhat similar bearing, page 1109, question 118.

Professor Taggart strongly implies the same thing, if it is not clearly stated, when he says (Q55): "Therefore if you increase the ~~amount~~ degree of agitation it will be necessary to increase the amount of oil that is to be used." I don't know how necessary it will be, but it will be possible to do it.

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Question 47, Professor Taggart, in reply to the question "What is the effect of the emulsification of oil—?" answered: "The idea of such agitation is to break up the oil xxxx into an extremely large number of extremely small particles." That is again a clear confirmation of the part of the conclusion which indicates that by breaking the oil up very fine it is possible to very largely overcome the dangers and difficulties found when you overload a particular particle with oil of any size. One of the things that I think the pictures will show rather clearly, is that when a mass of small particles gathers in an oil layer, they continue to gather until they reach the point where a load is applied to the oil-water surface, which is too large, and then they break through in a sort of reverse water spout. Now, that action is largely prevented if the oil is broken up into small particles, making it possible to add more oil without producing so predominant an amount of oil froth.

There are, as I have indicated before, a number of places in the testimony where a contradiction of the statement is based very largely on a different understanding of the words; but it is here and there based on a misstatement of the question under discussion. The best illustration of that, perhaps, is the question of direct attachment to the bubble. Another is Bancroft question No. 120: "Would it seem likely to you that these things you have stated might cause one to conclude that the air bubbles ~~did~~ do not directly attach themselves to the oil globules and have slight, if any lifting power" when attached?"

There has been at no time a statement that air did not attach itself directly to the oil globules. One can hardly conceive of a more direct attachment than that sudden embracing—grasping of the whole circumference in a layer or film of oil. What was stated was that it does not readily—and it was seen yesterday and will be seen very much more clearly in the moving pictures, where a number of clear, precise images can be taken in a small part of a second, how the air bubble when brought in contact with an oil globule so frequently bumps it aside, and indicates very clearly that there is no readiness or quickness of attachment. Before it breaks through, the intervening layer of oil seems to snatch the bubble, and fasten all around it.

Another case is question No. 137: "Do you consider the proposition correct or incorrect that the fundamental principles of ~~air~~ flotation are air entrainment and the increased affinity of the air for the metallic particles in the presence of a frothing agent." Whereupon Prof. Bancroft endorses the air entrainment as he understands it, criticising the use of the word, but not the idea, and then says that the statement that affinity is increased, is very wrong. As a matter of fact there has been no suggestion that affinity was increased, in the sense of an increased holding power or power of attachment. The ease of attachment has been testified to by the other witnesses, and in fact it is the adsorption film that they have all contended that produced the attachment at all.

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In conclusion, both commenting on the conclusions that have already been advanced and on the testimony, I would prefer to avoid theorizing on what happens or what might happen if what does happen didn't happen; the facts can all be made visible in one form or another, and the distinctions that are drawn should not be too fine. The distinction between an oil froth and an air froth, or perhaps we should say between a condition of oil and minerals—th~~at~~e air and mineral in an oil froth and an air froth—These are not imaginary distinctions, and are not taken down to the vanishing point of an extremely minute film. It is not my desire to overlook any pertinent scientific fact or to gloss it over. The statement in regard to why mineral wets with the first few millionths of an inch of oil surface, is interesting; as far as I can judge it is something of an explanation—at least it enables us to conceieve what could happen. At any rate it gives us another name for our ignorance when we call it adsorption; but unless the differences or similarity between the processes of air froth flotation and the bulk oil floats, aided by entrapped air, are something larger—something more tangible than the adsorption layer, that it will be difficult to recognize with an ultra microscope, and in dealing with which we must seek the aid of theory and a vivid imagination—unless the thing that causes the difference is down in that minute range, I conceive it were better simply to say that mineral wets, that the oil spreads a film over the bubble, and deal~~s~~, as Professor Bancroft recom-

mends, with the facts rather than the theory. Those differences are the only similarities that I can find that the experts for the defense have been able to produce between the air froth and the air floated bulk oil conditions, that is, some subtle physical chemical laws, which continue to act throughout all ranges of oil, whenever the materials come in contact, but act through practically no range of distance; and it seems to me the essential phenomena with which we are dealing are phenomena which must occur at tangible distances; in fact there is testimony by the other experts to the fact that a monomolecular layer would be entirely inefficient for flotation purposes. They rather contradict each other there, when it is testified that a single molecule in a ton of pulp would float a single molecule of mineral, but the practical sense of the thing is agreed. These physical chemical principles I do not deny, but it seems to me that they make no difference. What happens within an adsorption layer a millionth of an inch thick is not useful to hold a particle of mineral indirectly attached by one-hundred~~th~~ or one-thousand~~ths~~ times that thickness of oil in the mass. There is nothing left but what Professor Bancroft has described as weak cohesion of the oil.

It is also interesting to note that the amount of oil shown—the point at which the limits are met, seems to have a connection with the experiment that we make in oil flotation, as it is called, and falsely called, in my opinion, because it is really and essentially air flotation—and it is more perfectly embodied the less oil we

have down to an extremely minute amount—so that if we try to increase the amount of oil above those minute amounts, my experiments have indicated that we run into trouble at just about the limits which are indicated by the necking off of the oil. I do not deny the possibility of the truth of all the fascinating theory, but submit that it has no place in court until related to actually observed results, and it certainly should not be permitted to obscure our clear vision of an obvious fact, capable of photographic record, the necking off or weak coherence of that oil layer which occurs when the amount of oil becomes a useless excess over and above the sufficient amount.

MR. WILLIAMS: Direct examination is closed.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 53. In your answer to question No. 10 on page 2133 of the typewritten record, you say: "When I speak of a film or layer I mean to try to make some distinction between the two, because a film is a thin layer, and while it is true that no major limit can perhaps be set to the thickness of a film, I should regard it as absurd to speak of a n oil film, ~~an~~ or adsorption layer anything like one-hundredth of an inch thick." Now, is it your intention to confine the meaning of the word "film" to an adsorption layer?

A. If by adsorption layer, you include all thicknesses of layers which can be reasonably expected to be affected by adsorption phenomena from either side—

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X-Q. 54. Well, then, how great a thickness can you reasonably expect?

A. Pardon me; I do not want that to be regarded as the end of my answer; that was not "yes." I was going on to make an explanation. If we so regard an adsorption layer, I think the thickness of a film, scientifically speaking, where film is distinguished from layer, comes pretty close to being that thickness. In most of my testimony I have tried to use the word in that sense; but as is necessarily the case in the use of words, it has been used also to mean layer, to convey the idea of a layer which was sufficiently thin to be characterized by those properties of surface, without any precise distinction of whether there was a minute amount of excess material in between or not.

X-Q. 55. (Last question read): "In your answer to question No. 10 on page 2133 of the typewritten record, you say: 'When I speak of a film or layer I mean to try to make some distinction between the two, because a film is a thin layer, and while it is true that no major limit can perhaps be set to the thickness of a film, I should regard it as absurd to speak of an oil film, ~~an~~ or adsorption layer, anything like one-hundredth of an inch thick.' Now, is it your intention to confine the meaning of the word 'film' to an adsorption layer?"

A. Why, I have just stated that I did not mean to confine it to a single adsorption layer, or necessarily to a pair of adsorption layers on each side of

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a film; that there might be some matter in between that pair of adsorption layers; but I meant to include down to the range so that the predominant properties were the properties of surface films.

X-Q. 56. Well, how do you ascertain what the predominant properties are, the properties of the adsorption film or adsorption films?

A. From scientific measurements, by observation of the behavior of materials when brought into contact.

X-Q. 57. Can you give an instance of some test by which things can be resolved into some degree of certainty?

A. If for instance and illustration, in diagram No. 2 where the surfaces are close together and both come down as one onto the surface of the mineral or where they come into actual contact—so far as we can see and judge by their behavior, in contact with the mineral. As Professor Taggart described it, displaced by the presence of the mineral in the under side and displaced by the presence of the mineral in the upper side. in the physical material he was examining, and if in moving or agitating or straining the particle, it seems to carry these films with it. I think it would be clearly observed that the particles were within the range of the action of the film, or film within the range of action of the particle.

X-Q. 58. Well, now, wouldn't that depend altogether upon the size of the particle that happened to be in there?

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A. Naturally the extent to which the film was swung aside would depend on the size of the particle.

X-Q. 59. Are these surface adsorption layers that lie on either side of the imbedded particle?

A. Why, in the broad, general use of the word I should say yes. There are supposed to be differences of concentration there.

X-Q. 60. Now, you have said this relation between the surface of the film and the particle is of course related to the size of the particle. Well now, suppose we have a large particle, a forty mesh particle, that will just go through a forty mesh, and that is embedded in oil and film and shows the projection on each side as the interaction between the particle or the film or layer, whatever you call it, would that be a film in the sense you use the word?

A. I do not quite get the question clearly.

X-Q. 61. What I am trying to get at, doctor, is the measure you have given me seems to depend on the size of the particle. Now, I want to know how large a particle so manifesting itself will indicate that the structure is a film?

A. It is dependent on the size of the particle only insofar as the excess over and above that required to produce the film is concerned. If you have a large particle it will be necessary, in order to surround that particle with oil, to get a larger amount of oil from the film. If you have a small particle, it will take a little less oil to include that particle in an excess and

permit the particle to move down out of direct contact with the bubble.

X-Q. 62. Just what do you mean by the particles move out of direct contact with the bubble?

A. The bubble, as I have tried to define it is constituted—and as the other experts have defined it—is constituted of air surrounded by certain films which constitute a part of the bubble. If you get enough material, oil, about that bubble, the oil assumes a thickness sufficiently great to behave like oil in mass. If that particle is extremely large as compared with the particles used in ore flotation, it will take more of that excess to make the difference evident to the eye. Is that clear?

X-Q. 63. Makes what difference evident to the eye?

A. The difference between oil in bulk and oil in film.

X-Q. 64. Well, can you state this in some kind of measurements? I must say that I haven't got the point where one leaves off and the other begins yet.

A. Measurements of the particle or the film?

X-Q. 65. The film.

A. I don't get what film you want me to give a measurement of?

X-Q. 66. Well, if I have been able to grasp any point at all so far it is that when we have a certain thickness of oil surrounding the air we have a film in which, as you say, the oil functions somehow other

than oil in mass; but when we have more of a film there and more oil it functions as you state as oil in mass?

A. In the film, you mean?

X-Q. 67. What you mean is what I am trying to find out?

A. Read the question.

X-Q. 68. (Question read as follows: "Well, if I have been able to grasp any point at all so far it is that when we have a certain thickness of oil surrounding the air we have a film in which, as you say, the oil functions somehow other than oil in mass; but when we have more of a film there and more oil it functions, as you state, as oil in mass?")

A. The functioning that I have in mind is the observable functioning depending on the size of the particle, the condition of strain to which it is subjected and as I say that varies with the size of the particle, the condition of straining, character of the oil.

X-Q. 69. What is this condition of strain?

A. In the case of a free moving bubble that I have photographed it is the inertia of the mineral particle being seized and carried to the surface by the bubble. In agitation it is the whipping and turning and movement of the liquid, and, again, the inertia of the mineral particle straining at the moving bubble.

X-Q. 70. And now, suppose this straining does not result in separating the particle from the film or layer, whatever it may be, you would say that there was direct attachment or wasn't to the air bubble?

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A. For the purpose in hand I should say that it was direct attachment, just as Prof. Bancroft spoke of the layer of oil when he was speaking of something more than a minute film, spoke of a layer of oil as tending to distribute itself evenly over the entire inside surface of the bubble; and then he said, "Under the force of gravity it certainly would not." Now, under other forces it would do so even less, and it is perfectly clear, it seems to me, that if you apply a greater force you can draw that film more and more to one side. If you have one oil you can drag that out to one side more readily than you can with another oil; and the net result as to whether you have direct or indirect attachment is the subject of final proof of whether it is attached or not.

X-Q. 71. That is final proof whether it is detached or not?

A. I think so.

X-Q. 72. Well suppose we assume that the conditions are those prevailing in the practice of this flotation concentration process. Now, as long as the mineral particles are not detached from bubbles, and are recovered in froth, you say it is direct attachment?

A. There are factors in what you have called "the commercial practice" that, frankly, I am not competent to speak of. I can speak of what I have seen, have tested, and know, but I do not pretend to be an authority on commercial flotation.

X-Q. 73. Then your testimony is not going to help

the court to decide whether, if the particles remain attached to the bubble sufficiently to be recovered in the froth, they are what you call "directly attached" or not?

A. That is a matter which the court must decide. I hoped it might.

X-Q. 74. You have no opinion or idea on the subject?

A. On that subject? I think it may.

X-Q. 75. Defining this direct attachment?

A. I don't quite get the question definitely.

X-Q. 76. I will restate it. You have referred to the direct attachment, which I cannot define for you. because I don't understand it. You have referred to an indirect attachment in which the particle pulls out the oil, you say, and becomes detached. Now, we have these two things, whatever they are. Now, in the practice of this flotation froth process or the pneumatic froth process, my question is if the air bubbles come to the surface and float and the mineral particles remain in them, and are recovered in these bubbles floating off from the froth, is that an indication that they were directly attached or that they were indirectly attached or that they were attached at all?

A. It would seem to me if they remained in the bubbles and are attached to the bubble, they are attached.

X-Q. 77. Directly, as you define it?

A. I think so.

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X-Q. 78. Regardless of the quantity of oil used?

A. If they remain in the bubbles, yes.

X-Q. 79. Well, the term "critical point" as created in this controversy, now where does that come in? The point where these particles fall off instead of remaining attached to the bubble?

A. The term "critical point" may scientifically be used for any change, any maximum or any minimum. Now, I want to know what critical point you refer to because I can't pretend to—

X-Q. 80. Well, a layman's definition of a critical point as given in the ordinary dictionary made for the common people is that it is a point at which transition takes place, a transition point, as far as I am able to grasp it. Is that correct?

A. That would be a perfectly correct definition.

X-Q. 81. How do you define it otherwise?

A. I have not attempted to define a critical point in any such connection as this. What I am trying to get at is, when you ask me about the critical point connected with the question, I want to know what you mean by that critical point. What is the meaning of it?

X-Q. 82. In this particular case?

A. Yes.

X-Q. 83. Well, I mean that point at which the direct connection ceases and becomes displaced by the indirect connection?

A. I should regard that as a very critical point.

X-Q. 84. And what is that as regards the amount of oil used?

A. Depending on the size of the mineral particle, (and I believe its character, although I am not quite clear about that yet) also certainly its shape and size and the character of agitation. All of these factors enter in to determine whether, as a practical proposition, something can hold on to something else.

X-Q. 85. Well, then, any given body of pulp containing ore ground, as it always is, to any considerable degree of fineness from the coarsest down to the finest, that is in it we have several million different critical points, one for each different sized particle there?

A. If the particles were acting alone, yes. If they are acting altogether you get a co-operative minimum, an average of what really works and doesn't work.

X-Q. 86. Simply have a composite?

A. Practically so, because the particles help to hold one another more or less. And you get what might be called an actuarial average. In other words you get a result.

Q. 87. Can't you give us that? If there is such an actuarial result, what is the point?

A. Not without a precise knowledge of all the conditions, and I frankly admit that I have studied the smaller particles, the particles by themselves, to ascertain the laws that might apply, and that, in my opinion, do unquestionably apply, rather than the actuarial averages of the commercial flotation process.

X-Q. 88. Well, now, do you understand that the direct connection, as you have called it, between the particles of mineral and the bubbles is the characteris-

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tic of the process described in the patent here in suit?

A. I am not an authority on the patent here in suit.

X-Q. 89. I am not asking you about it as a patent. I am asking you about it as a description of the process.

A. With regard to the process, if you mean a commercial process, why again, I am not, I think, qualified to speak. But, if what you mean is do I regard the question of whether it attaches or does not attach as being characteristic of what seemed to me the characterictic phenomena of this process as exemplified, I should say that it was quite clear in my mind that the specific example had direct attachment. There is nothing tangible or visible in the ordinary sense between the mineral and the air; certainly nothing between the mineral and the bubble.

X-Q. 90. By "the specific example" you mean the instance given of the quantities and of the kind of ore that appears on the first page of the patent in suit?

A. Not altogether. I do not mean to confine myself to one example rather than another. In fact I am not sure—I simply would not confine myself to that, but that would be included.

X-Q. 91. Well, what other thing would you include that is in the patent, the reference to using less than one per cent of oil? Do you refer generally to using two one-hundredths or five-tenths per cent?

A. No. When I take an ore, whether it is the

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ore mentioned in the patent in suit, which I have not had any large quantities of, and apply to these mineral particles a bubble of air, I find a certain condition attained. When I apply to that mineral an amount of oil which is calculated from the proportions of oil there given and the amounts of mineral in the ore, I find a certain definite characteristic kind of attachment of these particles to these bubbles which to my mind is characteristic of that process in the sense of scientific characterization. Now, to what extent that may be masked or overcome or overloaded with useless other material and still get away with the process commercially I am not competent to say.

X-Q. 92. What are these observations you make upon this ore that is mentioned in the patent? How did you proceed? That is what I want to know, to find out what the process is.

A. By mixing the material as thoroughly as possible.

X-Q. 93. Grinding it up first?

A. Grinding it up, yes.

X-Q. 94. How fine did you grind it?

A. The samples which I have had furnished me of the Broken Hill—I have not been to Broken Hill and have not myself obtained the ore—were ground. To this oil was mixed with a certain percentage specified in the specific example I believe, but as given to me, my recollection is 0.2 per cent or 0.1 per cent —the precise quantity was, so far as I was concerned, not limited—a minute quantity—and this is mixed

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with the ore, and the two are thoroughly mixed either by violent agitation in the pulp or dry mixing together, and then the condition of these particles is examined, they will be found to take hold of, or be taken hold of by the air bubbles in the way that has been described as direct attachment.

X-Q. 95. May I interrupt you? Just how did you make that agitation? You say that you have agitated this mixture and that the bubbles must have risen to the top or be rising. Did you make an observation to see whether the attachment was of one character ~~of~~ or another? How did you do that?

A. Did it in one of two ways, either to examine the film of the bubble as it stood with a glass or to examine the film of the bubble under the liquid with a glass. The other way is to remove the particle from the froth which is formed and examine the position of these particles in the bubble films, where they go. Just as Prof. Taggart described in the examination of his films, and he found that in the film—

X-Q. 96. That is what you found then?

A. That is what I found, that quantity of oil is minute enough and, in the illustration that we are discussing, it was practically impossible to see the inside film, but I have every reason to believe that it was there.

X-Q. 97. I suppose now you have examined these bubbles and froths made with larger quantities of oil and observed a different condition, have you?

A. The much larger quantities of oil unquestionably produce an entirely different condition.

X-Q. 98. Well, how much larger?

A. In the experiment that I have tried under the conditions that I have been working, twenty-five per cent perhaps on the weight of the total material would produce a condition that was to me radically different from the other.

X-Q. 99. Twenty-five per cent?

A. Twenty-five per cent.

X-Q. 100. On the weight of the ore or the mineral?

A. On the weight of the ore, but presumably a large majority of the oil went to the mineral—I am not prepared to say just how much there was on the mineral.

X-Q. 101. How would you characterize the float which you obtained with that twenty-five per cent of oil?

A. That would depend I think upon the conditions, many of the conditions which were used in obtaining the float. The floats that I have obtained with that quantity of oil were distinctly oil floats under the conditions that I was working.

X-Q. 102. And where was the mineral found in that float?

A. The mineral was found in that float included in masses or globules of oil which were, so far as I can judge, separated from the air masses by films of water, but certainly there was no tendency of the

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mineral to pull itself to the edge of the air. Just exactly as we saw yesterday the mineral, when covered in oil, does not seem to have any attachment for the air-oil interface.

X-Q. 103. Well, now we will assume that we have concentrated an ore by the method of adding oil to the pulp and agitating it and producing a froth and in that operation we have used say sixteen per cent of oil relative to the weight of the ore and we will assume further that we have made a highly satisfactory recovery as to the grade of concentrate. Now, under these conditions you will grant that the mineral is floated. Now, what I want to know is whether that attachment of that mineral is direct or indirect, for that quantity of oil, and if there is any medium place in between? Did it have any element of directness in its attachment to the air.

MR. WILLIAMS: I would like that question read.

X-Q. 104. (Question read.)

A. By "attachment to the air" you mean attachment to the bubbles in the sense that I have been using it?

X-Q. 105. Yes, to the bubbles?

A. I would say first that I can only determine that by examining the material as I find it. I cannot decide from any hypothetical set of conditions which I have not carried out in the first place, and all of which are not specified in the second place, what I would get.

X-Q. 106. Then, under the condition of my question, it is purely a matter of scientific investigation to determine these things?

A. It is a question of fact what happens.

X-Q. 107. Yes, scientific fact. The directness or indirectness of attachment of the particles to the bubbles cannot be determined at all by the fact that the mineral is floated and recovered and sold at a profit? That has nothing to do with this distinction, has it?

A. I can conceive of mineral being recovered, floated—if by "floated" as I understand in your question you simply mean carried in some way to the surface without its being an air froth flotation. I may have missed a portion of your question, but I don't recollect that that was so defined.

X-Q. 108. So I take it that on any given operation of concentration at any mill, nobody but a man of scientific attainments and with scientific apparatus and equipment and after a scientific examination and careful testing would be able to tell whether this mineral was or was not directly attached to the bubbles?

A. You are asking me about the characterization with which I am familiar, and in which I am competent. What another man could do is not for me to say, but I suspect that the treasurer might be able to tell.

X-Q. 109. What?

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A. The treasurer might be able to tell.

X-Q. 110. You mean the treasurer of the company?

A. Yes.

X-Q. 111. Whether they make money or not?

A. Yes.

X-Q. 112. That is the test is it?

A. No. I think he might have his ways of determining just as I have mine, and as the men who are operating the cells seem to have theirs when they recognize the desirable conditions for working or the less desirable conditions for working, and go and vary it according to their own judgment. But my way of determining the thing is the way which I understood you to ask me about.

X-Q. 113. And that required painstaking and careful scientific investigation, did it not?

A. That is what I am ready to do.

X-Q. 114. They do require it, do they?

A. My ways do, yes.

X-Q. 115. And you do not know of any other way, do you?

A. I know of many other ways in which I am not skilled, as I say. I know that the men at the cell can tell immediately whether the conditions are desirable.

X-Q. 116. From what viewpoint?

A. From their viewpoint.

X-Q. 117. Is that the viewpoint of finding out whether they recover the mineral or finding out

whether there is some kind of a particular attachment between the mineral particles and the bubbles?

A. I presume purely from the question of recovering the mineral, and in a few cases all I want to know is whether the mineral sticks to the bubble?

X-Q. 118. Well, now, do you believe there is a critical point between this direct attachment and this —whatever you call it—indirect attachment of the mineral to the bubbles? Is this something that changes like a snap of the fingers at a certain point, or is it something that melts away gradually like the difference in the colors from one end of the spectrum to the other?

A. Under any precisely fixed set of conditions, if you can assume such a fixed set of conditions, I think that the limit comes with reasonable sharpness. And by that I mean a relatively small difference in the amount of excess oil.

X-Q. 119. Well, a difference of what magnitude?

A. Ten or fifteen per cent of the amount of oil present, perhaps. Something in that order.

X-Q. 120. That is for instance if one per cent gave you direct attachment, your estimate is that 1.15 per cent would be a suitable increase to go beyond this critical point?

A. As I have measured the thing with all the conditions fixed, as carefully and accurately as I could determine them from changing the rate of movement of the bubbles, from changing the size or the shape of the bubbles, you get an entirely dif-

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ferent state of things, and no such approximation I think could be made for widely varying conditions such as would be found in the agitation cells that I have used for experimental work. You have almost an actuarial average there.

X-Q. 121. Well, assuming constant conditions, and assuming that we get a very satisfactory result with one-tenth of a per cent of oil relative to the weight of the ore, now we will say farther that we increase that amount by fifteen per cent, which would give us, if my arithmetic is right .115 per cent of oil. Now, this condition being constant, and we getting a good result with one-tenth of a per cent of oil, when we increase that to .115 per cent we are, in your opinion, beyond this critical point, and operating without the direct attachment which you have defined?

A. Now, let me make sure that I understand you. You are speaking now of a definite critical point as I understand it. You are speaking of a point which is the amount with which you get your best results. Or are you talking of the maximum amount with which you can load the process without totally defeating it?

X-Q. 122. I am not talking about either of them.

A. Then I don't understand.

X-Q. 123. I am talking about why you haven't answered my question. I asked you what the critical point was and you said it was reasonably definite. And I said "How definite?" And you said it would

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be accurate within a range of fifteen per cent of the amount of oil you were using. Now, I assumed that we were getting a good result with one-tenth of a per cent of oil.

A. What is a good result?

X-Q. 124. I do not say the best result; we are getting a direct attachment. Now, I don't understand that there are any different kinds of direct attachment. It is the direct attachment with the one-tenth of a per cent of oil. Now, I raise the amount of oil by the amounts which you said will cover this, as I understand. Now, my question is have you destroyed the direct attachment, as your testimony indicates it would, and, as to operation, would some of this oil neck, or stretch out (oil films) that you have been telling about, which are not the direct attachment?

A. If you had your mineral just on the surface of the bubble, as I have had it when I have been working with them, and if conceivably you had an oil so light that such a small fraction could not merely coat the bubble, but coat the mineral particle to the point at which it separated from the bubble surface, and if then you assumed that to be, you had that maximum amount which will hold it, you then add ten per cent, my experience is that you let that particular particle go from that particular bubble.

X-Q. 125. You do what?

A. That you let that particular particle go from

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that particular bubble which supports it. Does that answer the question?

X-Q. 126. Aren't you getting a little afield? I thought my question was pretty definite?

A. I think not.

X-Q. 127. We assumed the conditions were constant except that of oil, .115 per cent of oil. Now, the question is have you destroyed the direct attachment and is the particle wobbling around at the end of a dangling neck of oil and therefore outside of this point? That is definite. That ought to be susceptible of an answer?

A. It is, provided you make plain or answer my question as to what you meant by "critical." You have been speaking of a critical point to get a good result in the case. Might I carry the implication that this is all that you can use to get the best results, or is this the least you can use to get the best results?

X-Q. 128. One-tenth of a per cent, you mean?

A. The one-tenth of a per cent.

X-Q. 129. Are there several kinds of direct attachment, best direct attachment and so forth? I understood that that was a definite thing and one-tenth of a per cent gives it to you.

A. It is just as definite as the fact that I can nail a board to the floor with forty nails or with one nail. Now, you can have direct attachment with anything less than the amount of oil which will defeat direct attachment.

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X-Q. 130. I think I get your idea, doctor. Now, we will assume this, that we get the direct attachment with one-tenth of one per cent of oil and that that is the maximum amount, according to your ideas, that will give the direct attachment. Now, I give you that, I have answered your question because of course if you add anything to that you wouldn't have it?

A. Exactly.

X-Q. 131. How wide a range is there over which you can get this direct attachment—how wide a range in quantity of oil; do you know any concrete instance of that?

A. You mean from the maximum that will produce direct attachment to the minimum that will produce direct attachment?

X-Q. 132. Yes.

A. The minimum that will produce direct attachment, as has been stated, is nothing at all, because you can get a perfectly satisfactory direct attachment without the use of any oil. The maximum, as I said, is something which I can not specify without accurately given physical conditions. In the cases that I have observed of the captive bubble, (which is the only one actually where you can make accurate measurements—and that was the reason for selecting it) ~~in~~ the amount of oil there, even, depends on the character of the oil (and to some extent on the presentation of the bubbles to the oil; but the presentation of the bubble has very much less effect) within ranges that

seem to me to be about ten or fifteen per cent. The amount of oil in a given case is about the same.

X-Q. 133. You showed us the attraction of an air bubble for mineralized particles in water yesterday, didn't you?

A. Yes.

X-Q. 134. Then you oiled the particle?

A. Yes.

X-Q. 135. And after you removed as much oil as you could with the air bubbles, there did not seem to be as much attraction as there was without any oil; did not that seem to be the case?

A. After having removed as much oil—

MR. WILLIAMS: Read the question.

X-Q. 136. (Question read as follows: "And after you removed as much oil as you could with the air bubbles, there did not seem to be as much attraction as there was without any oil; did not that seem to be the case?")

A. By "attraction" you mean the strength of attachment?

X-Q. 137. The force that held them together.

A. I think slightly less; all the testimony shows that.

X-Q. 138. That the presence of oil decreases the strength of attachment?

A. Yes.

X-Q. 139. Now, when you told me that a decrease of 15% in the amount of oil being used would

be sufficient to cover the critical change and effect the transition from a direct attachment to an indirect attachment, what are you figuring the 15% on, the minimum amount or the maximum amount that would cause direct attachment?

A. I have stated, the maximum.

X-Q. 140. Now, what is the maximum in any given case; can't you measure it in terms of thickness of the film or weight of the oil, or is there no way on earth to tell what it is, other than to characterize it as a maximum?

A. As I said, there is no broad maximum. That is easy to understand. The size of the particles, the relative size of the particles, the character of the mineral and the shape of the mineral all make a difference in what amount of oil will be required as a maximum; but the general range of that maximum, and in many specific cases as I have carried it out that maximum is in the vicinity of three or four per cent up to six or eight per cent of the actual weight of the metallic particle. Those determinations were made with bubbles, which raised particles of selected size and weight, and as I say, the difference in the size of the particle will make a difference in that point; but there seems to be in every case this limit, beyond which we can not go without destroying the strength of the attachment. Now, in a general way that limit comes in that general vicinity. If we take a particle which is the maximum that a bubble will

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carry—I mean the maximum that the attachment of the bubble will sustain, and you get right up to the limit, so that it is attached but you don't know whether it will stay on there at all—a condition which may be compared to the flotation of metallic platinum —where the strain on the bubble is extremely heavy, th~~at~~en the limit of oiling or impurity on the surface is very quickly reached.

X-Q. 141. Now, I say you have told me that when you claimed that 15%, you meant to base it upon the maximum amount that would produce the direct attachment of the particle to the bubble?

A. Yes.

X-Q. 142. Now, if we state the maximum amount that will produce it, doesn't that mean that an infinitely small amount above that will destroy it; if it is the maximum, why do you have the 15%?

A. Because I speak of determinations I made and measurements which I have carried out, and in that class of experiment, no man, when he speaks of a maximum amount, undertakes to carry it out to a fraction of a per cent. We are dealing with measurements, and I speak, not of the fact that 15% more would do it, but that 15% was about the range of my determinations. I don't know whether it is a fact that under one set of circumstances, a change in the temperature or something else, 15% more is permissible. But of course, mathematically what you say is perfectly correct.

X-Q. 143. Then you did not mean the maximum at all, but you meant that your determinations had in them an element of error equal to 15%, and so that to allow for that element of error you would have to add 15%, not because the critical point in that amount was indefinite, but because there was an area of error that had to be covered?

A. I think it may be either a variation in the accuracy of the determination or a variation in the conditions. We speak of the tensile strength of steel, and that varies with the rate at which the load is applied, and varies with a number of conditions which are too minute in many cases to be sure just what they are; so we speak of the maximum tensile strength, and I was speaking of it in the practical common sense way, rather than in a mathematical way.

X-Q. 144. Now, I wanted to know about the particles as to how much oil would destroy the direct connection, and I find you said about 3% of the weight of the particle. What sized particles are those that you experimented with?

A. I don't think I said 3%; my recollection is that I said from four to eight per cent, depending on the conditions.

X-Q. 145. Well, four to eight per cent. I did not intend to misstate it. What was the size of the particles upon which you made that determination?

A. Those determinations covered by that range have been repeatedly carried out with galena particles

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weighing from four to six milligrams, selected to be as near cubical as possible, and on aluminum discs, which I stated yesterday were 5/32nds in diameter, punched out, and having a weight of from 27 or 28 up to 35 or 40 milligrams. As compared with the maximum lifting power, I think perhaps it would be well to know what standard of comparison they are, because their relation depends on whether the bubble is correct in size, because if you have an abnormal relation between the bubble and the particle, you can vary almost any measurement; just as the contact angle almost disappears when the bubble is under strain if the bubble is too small; but the maximum was about 40 milligrams of galena and about 104 milligrams of aluminum disc. Now, it makes a great difference what oil you use, too.

X-Q. 146. Will you tell the court how many million times as heavy these things you experimented with are, than an average sized particle which is concentrated by flotation; I can give you the screen analysis of the Butte & Superior, if you want it, to make it definite.

A. I don't think that is necessary. I think the question can be answered in a very general way, that the weight of those particles is proportionately greater as the violence of the movement is proportionately less; that there is no necessary connection between the weight—

X-Q. 147. I wish you would answer the question

and explain afterwards; I want to know how many million times greater these particles you experiment with are than the particles met in ore flotation.

A. I haven't calculated it.

X-Q. 148. Can you do so?

A. I think so.

X-Q. 149. They are several million times as great, aren't they, according to your ability to size up the situation without calculation?

A. I don't know as it would run into millons, but it is a pretty large figure, yes.

X-Q. 150. As I understand what you have said, the quantity of oil which will result in this direct connection can not be determined by any relation to the weight of the ore itself?

A. I made no such statement.

X-Q. 151. What would you determine it by? If it is determined by the relation to the weight of the ore I want to know it?

A. The only way I know of to determine it would be to try it and see whether it produces direct attachment or not.

X-Q. 152. That is the only way you can find out? You can't tell by the thickness of the film?

A. With any particular oil or with any particular ore, I think that would be the only final way of doing it. You have certain past experience that would lead you to expect certain results, but the only way to be sure would be to do it.

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X-Q. 153. I want to read something that you testified to yesterday, and ask a question: "By attachment, either indirect or direct, and possibly very intimate, between the ~~oil~~ air and the mineral, I do not limit the kind of attachment to surface tension or electrostatics, or any other cause or method of attachment; but when I speak of direct attachment I mean the direct attachment of that mineral particle to the air bubble, which is intimate and physically immediate, holding the two together as a whole, with whatever adsorption layers there may be on the surface either of that mineral particle or of the bubble as a whole. Where something comes between the mineral and the air, with ~~ore to~~ a practical, substantial, effective action to ~~extent which~~ separates them in space and materially affects their inter-action ~~connection~~—for the purposes in mind. I would call the attachment then an indirect attachment." Page 2137 (Q 9). Now, that last sentence seems to hinge this indirect attachment on something interfering between the inter-action of the air with the mineral. Now, I don't understand what you mean by that; do you mean that the air exercises an attraction for the mineral as a magnet does for a piece of iron?

A. Before going into the answer—I haven't seen the record—There is period before "where" is there not?

X-Q. 154. Yes. Do you want to look at it?

A. As I stated yesterday, there are two possibilities, both of which are recognized in the testi

mony of the experts for the defense. One is that the mineral is attracted by air (in the broad general way that metal is attracted by a maget—by some force). The other is that there is an action of the bubble films (as, let us say, stretched membranes, to abbreviate). I think that both of those are capable of producing direct attachment. To what extent one or the other is effective I think depends entirely on the conditions.

X-Q. 155. When you pick up a bubble in the bubble holder in pure water, as you did yesterday, what is your opinion as to the force that holds the particle to the bubble?

A. You are now speaking of pure water and a clean particle?

X-Q. 156. Yes.

A. I think that the attraction of the air for the mineral particle at the surface of the mineral particle prevents the getting in of water over that surface of the mineral (and you might call it adsorption of that air layer if you like to step behind another veil), but it is simply and finally the non-wetting character of the mineral, caused, in my opinion, by the air, which forms at the outside of that area of non-wetting a wall against the water, and that that wall of air on the inside of the water on the outside, has what we call a surface tension, and that that lifts the particle.

X-Q. 157 That the actual mechanical lifting is done by this surface tension?

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A. As far as I know, yes.

X-Q. 158. And not by the air itself, except insofar as the presence of the air gives rise to this surface tension?

A. Insofar as the air is directly attached to the metal, and will not permit the water to come over, that is all.

X-Q. 159. But you don't mean that there is any tension through the air, that the particle hangs on air, or anything like that?

A. Why, air alone is as bad as the oil neck; it is very much worse; it has no cohesion whatsoever. You could not make a string of air and hang a particle on it.

X-Q. 160. Well, haven't you in your testimony referred to the attraction of air for a mineral particle as extending through films of a certain thickness, on which you get the maximum—"molecular action," I think you referred to it as?

A. Yes, and in that testimony I was speaking of precisely the same phenomena—perhaps in less scientific words—that Professor Beach and Professor Taggart, as I recollect, both referred to—both spoke of there being a commingling, and what they were talking about as an adsorption layer, between the air and the oil, and the layer between the oil and the mineral. As I understand it, if there is an adsorption layer of air and mineral, it holds back the water. It is the attachment of the air to the mineral which really, followed back as far as you can go, does the work. In this case,

if the air gets through a minute film of oil, and is still effective to hold back that water wall, I would call the element of that attraction a part of the lifting force.

X-Q. 161. Really in the same sense that you apply it to the bubble holder?

A. Substantially so; not as a string.

X-Q. 162. In your diagram No. 1 which you submitted yesterday, as I remember it, you showed the outline of the bubble which presumably is the wall of the bubble—whatever it may be scientifically—as bulging at one point, and the particle lying inside of that wall at that point. Now, if that is the correct representation of the particle, that is oil within the wall of the bubble, how was it that, when you lifted the bubble holder out of the pure water yesterday with a bubble on it, you found the particle covered with quite an appreciable amount of water, or at least if not covered, carrying it in spots?

A. I did not find the particle carrying any.

X-Q. 163. My recollection was that you found it wet after you took it out. I may be mistaken.

A. I don't know what surface that was, and if the diagram indicates—the diagram appears to be missing.

MR. WILLIAMS: It was sent to the printer to be copied and has not been returned yet.

THE WITNESS: There was no intention to imply by that diagram that there was or was not any contact between the water wall and the under side of the mineral particle.

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X-Q. 164. I think the diagram was a little ambiguous in that respect. We will take that up later when the diagram is here.

A. There is no question but what there are portions of the under face of the particle that are wetted. Examinations with the microscope at different temperatures leads me to believe that that is not a continuous wetting by any means. How far that was effected one way or the other, I don't know, but broadly speaking I should say that the under side of that particle was at least partly wet.

X-Q. 165. Here is a passage that I don't quite understand. I would like you to explain; page 2140: "In my opinion it is quite possible that there should be such attachment directly through an oil layer if the oil layer is sufficiently thin, though it is obviously not necessary or essential to the success of the air froth process as far as we can see today." Do you mean by that that it is direct connection of the mineral particle to the bubble, that that connection is not, as you say, essential to the success of the air froth process; that is, does the air froth process include something else, and if so, what?

A. No; I meant that the intermingling of the air and oil at the inner face of the oil layer or film—film is better here because we are dealing with an extremely thin layer—intermingling at the inner face of the oil film, of the air and oil, and the intermingling at the outer face, of the mineral and oil, may have no effect. The correctness or otherwise of that theory—the correctness or

otherwise of my belief that there is an action through a sufficiently minute oil film on the air on the inside, is not in my conception at all necessary, to direct connection, and therefore not necessary to air ~~oil~~ flotation; that is simply one of the ways in which it may be effected.

X-Q. 166. Now, I think that this direct action which is referred to here is the action of the air inside of the bubble extending through the distance that this molecular action does extend, and assisting in some way in drawing the particle into the wall of the bubble, is that right?

A. To put it the other way, holds the water back from the face of the particle.

X-Q. 167. Holding the water back, yes. Now, if that element is not present, you can still have what you call direct connection?

A. Something else may prevent the water wall from coming in, or the liquid wall, perhaps I should say.

X-Q. 168. What else, doctor?

A. Precisely the same forces which are recognized when we speak of an extremely minute adsorption layer of oil on the inside of the bubble, inclosing the mineral particles. There are many forces that work there, and I do not mean to exclude the forces either, which Prof. Beach and Prof. Taggart have included there, but to point out, as I said, that it is not material, except as to illustrating the relative thickness of the layer. There is no difference of opinion between us there that I think is serious.

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X-Q. 169. Now, you would include in this direct attachment the drawing in of the mineral particle into the bubble film by adsorption, regardless of whether it was beyond the direct molecular action of the air inside the bubble or not?

A. Direct contact?

X-Q. 170. (Question read as follows: "Now, you would include in this direct attachment the drawing in of the mineral particle into the bubble film by adsorption, regardless of whether it was beyond the direct molecular action of the air inside the bubble or not?")

A. Yes, provided the film were a film and not a mass of oil. I would not include as direct attachment the mere taking in that has been called adsorption; (I think it is a loose use of the word)—the mere adsorption of the mineral particle into an oil-water interface which was remotely connected somewhere with a bubble of air.

X-Q. 171. But the force of adsorption would be just the same, wouldn't it, regardless of whether you had a layer an inch thick or one very thin?

A. That was precisely the point that I brought out, that I don't think the connecting phenomenon is the adsorption phenomenon at all, because the adsorption is equally capable of moving the mineral particle into a ton of Elmore oil, or into the vanishing, almost infinitismal quantity of the air froth layer or film of oil.

X-Q. 172. Then the direct attachment we were talking about in these last few questions and answers, it is

not dependent upon this direct molecular action of the air within the bubble, as you term it, I think—it is not necessarily or essentially connected with the drawing in of the particle to the film by adsorption, but the direct attachment is wholly a matter of the thickness of the oil layer upon the bubble, because those are the only three things there are?

A. For any given set of conditions, oil, mineral, bubble, etc., yes; that is purely a question of the thickness of that layer at any given set of conditions.

X-Q. 173. Now, your position, as I understand it is, that when that layer is very thin, we have what you call direct attachment, and that direct attachment is a firm attachment—that when that layer has reached some certain thickness by reason of the thickness of that body of oil, the attachment becomes weak, and the oil pulls out, and the particle gets away?

A. That is my position, as confirmed by Prof. Bancroft's statement.

X-Q. 174. Now, do you say that between this layer that holds the particle tightly to the bubble and that thickness of oil which will pull out and release the particle, that there is any critical point? Isn't that merely a question of the degree of thickness, and that the attachment according to your theory will simply become weaker and weaker and weaker, until finally it is too weak to answer the purpose?

A. Under any set of conditions—you have a fixed load on a rope, let us say. It is a matter of degree, perhaps. By and by that rope breaks; but if you draw a

knife across it and cut one bit more than a certain strand, it is good bye.

X-Q. 175. Then the critical point—it seems to me we are making progress—is the point at which the particle breaks loose; that is the point in the thickness of the layer?

A. The critical point to which I refer and which I have tested in my work, is that critical point where the attachment ceases.

THE COURT: It seems to me like the problem of "What addition will make a heap of that which was not a heap before?"

THE WITNESS: Or, "When does a pig become a hog?"

Whereupon further hearing was adjourned until 2 p. m.

2 o'clock p. m., Wednesday, May 9, 1917.

MR. WILLIAMS: At first I wish to make a request of the court. We wish to show to your honor the moving pictures, and that has to be done in the evening, and we suggest an evening session on Friday.

THE COURT: What are these moving pictures—the ones spoken of by the witness?

MR. WILLIAMS: The moving pictures prepared by Dr. Grosvenor. Mr. Scott has consented to suspend the cross-examination of Dr. Grosvenor to permit another witness to come to the stand who has illness in his family and must return.

Albert E. Wiggin.

ALBERT E. WIGGIN, a witness for plaintiff, after being duly sworn, testified as follows:

DIRECT EXAMINATION.

BY MR. KENYON:

Q. 1. Give you r full name.

A. Albert Edward Wiggin.

Q. 2. Age and residence.

A. Thirty-two years old, residing in Anaconda, Montana.

Q. 3. Occupation?

A. Superintendent of concentration in the state of Montana for the Anaconda Copper Mining Company.

Q. 4. Will you give briefly a summary of your education and experience in metallurgical directions?

A. I was educated at the Massachusetts Institute of Technology graduating in 1907. From there I came to Great Falls to work for the Boston & Montana Consolidated Copper & Silver Mining Company in the testing department. After about a year spent in the testing department I was made assistant to Mr. Wheeler, the superintendent, and carried out miscellaneous tests and experimental work under his direction.

Q. 5. Is that a subsidiary of the Anaconda Copper Mining Company?

A. It is connected with the Anaconda Copper Mining Company through the Amalgamated Company. It was a subsidiary of the Amalgamated. With Mr. Wheeler I developed an improved system of water con-

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centration, which was installed at Great Falls, and during December, 1911, I was sent to Anaconda to install this system in one section of the mill at Anaconda. I remained in Anaconda, and during 1913 was made concentrating engineer for the Anaconda Company. During the latter part of 1913 I had charge of the construction of a 2500 ton round table plant for the treatment of mill slimes. This plant was put in commission about the middle of March, 1914. It operated successfully until the middle of December 1915, when it was replaced by an oil flotation slime treatment plant, using the Minerals Separation Company machines. During May and June of 1914 we started test work on the flotation process for the treatment of our concentrator slime and tailings, using a Minerals Separation Company machine, and I took charge of that work. We started to remodel our concentrator in January, 191~~4~~5, taking one section at a time and installing Minerals Separation flotation process to replace the tables at the lower end of the flow sheet. The remodeling of the entire mill, consisting of eight sections, was completed about the middle of January, 1916. On the first day of May, 1915, I was made superintendent of concentration in the state of Montana, for the Anaconda Copper Mining Company.

Q. 6. Will you now in some detail set forth the character and extent of the investigations that were made under your direction of flotation concentration at the Anaconda mill?

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A. Early in 1914 it was decided to investigate on a fairly large scale the treatment by flotation of Anaconda slime and mill tailing. For that purpose a standard-type Minerals Separation machine was installed at the Washoe Reduction Works during May and June, 1914. This was followed by the installation of a full-sized Callow pneumatic machine plant. In addition to the tests made in the standard-type Minerals Separation machine some tests were made using a Minerals Separation machine of the sub-aeration type.

During the series of experiments a large variety of oils were tested. Experiments were also conducted using both round-table feed and tailing to determine whether it would be better to displace the round tables by flotation for the treatment of the slime, or to supplement the round tables by flotation of the round table tailing.

A series of tests was also made on the treatment of the mill tailing by grinding followed by flotation to determine the relative merits of flotation and leaching for the treatment of this product. In addition, flotation tests were made on mixtures of oil tailing and slime.

The round-table feed referred to above is the total slime from the mill. It contains about 35 per cent colloidial solids and approximately 90 to 95 per cent of the total solids will pass through 200 mesh (0.067 mm.). It assays from 2.1 to 2.7 per cent copper.

The mill tailing referred to above is the total discard from the mill exclusive of the slime. It is all finer than

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2 mm. and about 90 to 95 per cent will remain on 0.25 mm. It assays about 0.60 per cent copper.

A brief summary of the flotation results follows:

Preliminary tests: A series of tests was first carried out to determine roughly the best conditions for flotation, using the standard Minerals Separation machine and treating round-table feed. The following reagents were tested, either alone or in combinations: Turpentine, crude oil, cresylic acid, stove oil, tar oil, Carolina oil of tar, argole, sludge acid, fuel oil, wood creosote, and sulphuric acid. In some of these tests sulphuric acid was used and in others it was omitted. Also, the effect of the temperature of the pulp upon the flotation results was tested by heating to various temperatures.

As these tests were merely preliminary, no record was kept of the amount of reagents used. It was conclusively proved, however, that the best combination of agents was sludge acid, wood creosote, stove oil, and sulphuric acid. Fortunately, of all the reagents tested, these happened to be the cheapest. It was also proved that the addition of sulphuric acid to the pulp was of decided advantage in the treatment of the slime. In two successive tests in which sludge acid, wood creosote and stove oil were used, the tailing assayed 1.25 per cent copper.

MR. KREMER: Will your honor permit us at this time—I note the witness is reading—would you permit us at this time to interpose an objection to this charac-

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ter of testimony for the same reason as assigned in the objection to the Atwater testimony that it is incompetent, irelevant and immaterial. Your honor stated in ruling you were admitting it upon the ground that it would tend to show utility. If your honor will permit a general objection to appear on the record at this time.

THE COURT: Very well, the objection will be overruled.

MR. KREMER: Exception. All of this will go in under the same objection.

THE WITNESS: When no acid was used—in two successive tests in which sludge acid, wood creosote, and stove oil were used, the tailing assayed 1.25 per cent copper when no acid was used and 0.3 per cent copper when acid was used. Since these tests were made we have omitted the use of stove oil.

Tests with Standard Minerals Separation machine: This machine, with the accessory apparatus, was installed in a separate building, south of the round-table plant. It had 16 agitator compartments, each two feet square and 14 spitzkasten, and was of the standard Minerals Separation design. This machine is known by us as M. S. Machine No. 1. The agitators were of the standard Minerals Separation type, the impellers being 18 in. in diameter and the agitators making 265 r. p. m. This gave the impellers a peripheral speed of 1,245 feet per minute. The machine required 45 to 55 h. p., including motor and belt transmission loss, when operating under a full load of slime pulp.

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The experimental work on the Minerals Separation machine was carried out by George A. Chapman, and staff, of the Minerals Separation Company.

The first products to be tested were the round-table feed and tailing.

The conclusions reached at that time on the treatment of this material were as follows:

1. The economic capacity of the M. S. No. 1 machine when treating slime as produced from the mill is from 80 to 90 tons per 24 hours.

2. The best combination of reagents for the treatment of slime seems to be sulphuric acid, kerosene, sludge acid, wood creosote and stove oil. There is some question as to the real value of the stove oil. Its principal function seems to be to make a more compact froth.

3. It would not be economical to retain the round tables.

4. It is thought that the best circuit density for the slime pulp for flotation treatment is about 12 per cent solids.

5. It is thought that about 70° F. will be found to be the most economical temperature at which to keep the pulp.

6. Acid seems to be absolutely essential to the successful treatment by flotation of our slime.

7. The addition of air in the last spitzkasten is of no advantage.

8. Any considerable increase in speed of the agitators above a peripheral speed of about 1,300 ft. per minute seems to be disadvantageous.

Treatment of mill tailing after grinding through 60 mesh.

These tests were made in the M. S. No. 1 machine. Mill tailing from sections 7 and 8 of the concentrator were elevated and then dewatered. The dewaterea tailing was then crushed through 60 mesh (0.25 mm.), in either a Hardinge mill 10 by 4 ft., or a tube mill 8 by 12 ft. The grinding mills were operated in closed circuit with a Dorr classifier, the overflow of the classifier being the final product of the system and going to the flotation plant for treatment.

These tests were started immediately after putting the Hardinge mill in operation. At first no sulphuric acid was added, and the pulp was not heated. We found, however. that the use of acid in addition to that contained in the sludge was of advantage. Some very low tailings were produced during these preliminary tests, but the concentrate was very low grade. It seemed to be of decided advantage to add the oil ahead of the grinding mill, the latter apparently making an ideal agitator.

Conclusions.

1. Although not definitely demonstrated, it is thought that the economical capacity of the M. S. No. 1 machine when treating sand tailing crushed through 60 mesh is about 175 to 200 tons per 24 hr.

2. The best combination of reagents seems to be sludge acid kerosene and sulphuric acid. However, a

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mixture of creosote, turpentine, and pine oil, in a non-acid circuit gave good results also. The non-acid circuit, however, seems to require more delicate adjustment and more careful attendance than the acid circuit.

3. The grinding mill makes an ideal agitator, and it is of decided advantage to add the oil ahead of the grinders.

4. The treatment of the mill sand tailing ground through 60 mesh should result in a tailing assaying not over 0.10 per cent copper and a concentrate carrying not over 30 per cent insoluble.

5. It is thought that the best density of pulp is from 25 to 30 per cent solids.

6. Heating of the pulp to about 70° F. seems to be of advantage, although there is a possibility that this heating may be dispensed with during the summer months without any injurious results.

7. Acid seems to be beneficial but it is not of as much importance as in the treatment of the slime.

Treatment of mixture of round-table feed and mill tailing after grinding through 60 mesh:

These tests were made in the M. S. No. 1 machine. It was thought that it might be of advantage to mix the slime and the reground mill tailing for flotation treatment. The acid sludge kerosene, turpentine and the sulphuric acid used were added in the flotation machine. In some instances, various mixtures of coal tar (70 to 80 per cent), creosote (17.5 to 22.5 per cent), and pine oil (2.5 to 7.5 percent) were used with the sludge acid. These were added ahead of the grinding mill.

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The average proportion of said tailing to slime in the mixture treated was 75.7 to 20.1, or 3.8 to 1. In practice the proportion of production of tailing to slime is about 3 to 1; thus our mixture was somewhat deficient in slime. The concentrate produced, 34.1 per cent insoluble, is of a good grade, but the tailing is high, 0.20 per cent copper. Theoretically, the tailing should have assayed about 0.15 per cent copper, assuming a 0.30 per cent copper tailing from the slime.

Although this test was not conclusive it was decided, from observation, that it is better to treat the slime and the sand tailing separately. Of course, the slime which is made in the grinding of the sand tailing is included in the sand tailing for treatment. This slime produced in grinding the tailing is much lower grade and more silicious than the original mill slime.

Tests with Callow Pneumatic Machine:

Tests made by Mr. Callow at his laboratory in Salt Lake on samples of our mill tailing ground through 40, 60 and 80 mesh, and of our slime, had given such promising results that it was decided to try out the Callow machine on a commercial scale. Accordingly, there was shipped here during September, 1914, five standard Callow cells, 2 by 8 ft., a Pachuca agitating tank and accessory apparatus, consisting of blower and sand pumps. This equipment was installed in the old 80-ton experimental leaching plant and was ready for operation the latter part of October.

In addition to the Pachuca agitator recommended by

P. 4286, L. 9, after " a " insert, " 0.10 copper tailing from the sand tailing and "

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Mr. Callow, we built a set of two mechanical agitators. These agitators consisted of a tank about 10 ft. long by 2½ ft. wide and 2½ ft. deep, in which revolved a horizontal shaft carrying a set of paddles. These agitators were belt driven from one motor and required a total of 25 to 30 hp., including motor, belt, and countershaft power loss. The agitators seemed to work well and had a combined capacity of about 60 tons of slime per 24 hr.

Treatment of Round Table Feed and Tailing—

Conclusions.

1. On our slime, air agitation is not as satisfactory as mechanical.

2. The capacity of one standard Callow cell is about 15 to 20 tons of slime per day.

3. The Callow machine produces a clean concentrate but does not give as clean a tailing as the Minerals Separation machine.

4. The Callow machine is more sensitive and requires closer attention than the Minerals Separation machine.

5. The cost of repairs would probably be less on the Callow machine than on the Minerals Separation machine. This cost, however, is comparatively small for either machine.

6. The power required per ton treated in the Callow system is just about the same as that required in the Minerals Separation machine.

In all of these tests the original feed was divided among the Callow rougher cells, operating in parallel. As a rule, there was one cleaner cell operating also. When this was operating the concentrate from the rougher cells went to it, the cleaner making a final concentrate and a middling which was returned to the system. The rougher cells made the final tailing.

Treatment of mill tailing after grinding through 60 mesh:

During the first few shifts the mechanical agitators at the Callow plant were used but it was soon found that they were not required—that the grinding mill gave sufficient and thorough agitation.

Conclusions:

1. The capacity of the standard Callow cell when treating ground mill tailing is about 75 tons per day.

2. No other agitation is required if the reagents can be added ahead of the grinding mill.

3. The use of acid seems to be of considerable advantage.

4. On account of utilizing the grinding mill as an agitator the Callow machine requires less power than the Minerals Separation machine.

5. The Callow machine is more sensitive and requires more attention than the Minerals Separation machine.

It was decided on the whole that the standard M. S. machine gave the better results.

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It was decided to remodel the plant for flotation and to scrap the round table plant.

Q. 7. Will you now give a description of the remodeled concentrator plant that was installed after that decision?

A. I have here a flow sheet of the remodeled mill and also of the slime flotation plant, which will supplement my verbal description.

The ore from Butte is receievd in 50-ton dump cars, and dumped into the concentrator bins. The concentrator consists of eight 2000-ton sections. The ore is first crushed through 2 inches, then screened over one inch, and the one inch to two inch product is treated by jigs. These jigs make a concentrate and a middling. The middling is further crushed and returned to the system. The minus one inch product is screened on ⅜ of an inch, and the oversize treated on another set of jigs, making a concentrate and a middling. The middling is further crushed in rolls and returned to the system. The concentrate from these two jigs is finished concentrate and goes to the smelter. The undersize of three-eighths passes over a 5 millimeter or 7 millimeter screen, and the oversize of that passes through a set of Evans jigs, which make a concentrate and a middling, the concentrate going to the smelter and the middling being crushed in the finishing rolls, through one and a half millimeter. The undersize of the 7 millimeter screen passes in 1½ millimeter screens and the oversize is treated by Evans jigs, making a concentrate and a middling, the mid-

dling being further ground in the finishing rolls mentioned above, through 1½ millimeters, and the concentrate going to the smelter for treatment. The total undersize of the 1½ millimeter screen passes through Anaconda classifiers, which overflow the slime material approximately passing 8/100 of a millimeter. This slime goes direct to the Dorr thickening plant, where it is thickened to approximately 15% solids, and is then sent to the slime flotation plant. The overflow from this Dorr thickening plant is practically clear water. The spigot discharge from the Anaconda classifiers, carrying material finer than 1½ millimeters, with the bulk of the slime removed, passes over Wilfley tables, where a concentrate is taken out and sent to the smelter and a middling is produced which goes to the grinding mills. These grinding mills consist of 7½ ft. diameter by 6 foot cylinder Hardinge ball mills in all sections except one in which there are 8x12 pebble tube mills. The crushed product from these mills goes to a Dorr classifier, from which the coarse sand is returned to the mill. The overflow from the Dorr classifier is approximately minus .25 millimeters, and passes to flotation. This product is fed by elevator into three standard flotation machines. The oil and acid are added ahead of the elevator which feeds these machines. The oil used is kerosene sludge acid, and sometimes we use wood creosote from the Cleveland Cliff Company, which is a hardwood creosote, and sometimes we omit the use of this; we use sulphuric acid.

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Q. 8. Give the quantities of oil and acid.

A. We use about three to three and a half pounds of sludge acid, and from six to eight pounds of 60° Be. sulphuric acid.

Q. 9. Per ton of ore fed?

A. Per ton of ore fed to flotation. The Minerals Separation machines make a clean concentrate from the first seven spitzkasten, and a middling from the last seven, which is returned to the feed to the machines. A portion of the pulp is overflowed from the last three spitzkastens, together with the froth. I might say that these Minerals Separation machines are standard type machines, having three foot square agitating compartments, and the usual form of spitzkasten. The agitators make 225 r.p.m., which gives a peripheral speed of about 1410 feet. They are driven by 150 h.p. motors, actually using about 90 h.p. The spigot product from the last spitzkasten is the final tailing, which is sent to the dump. The concentrate from the first seven spitzkasten is finished and goes to Dorr thickening tanks and then to Oliver filters and to the smelter. This completes the treatment of the spigot product from the Anaconda classifiers.

The slime which overflows from these classifiers is, as I said, thickened and passes to the slime flotation plant. This plant consists of 20 standard type Minerals Separation machines of the same design as those used in the main mill. The first nine spitzkasten of these machines make a finished concentrate which is de-watered in Dorr tanks, followed by Oliver filters.

and sent to the smelter; the last five spitzkasten make a middling which is returned to the original feed of the machines. The spigot product from the last spitzkasten is a final tailing, which is rejected. I might say that the 20 machines are fed in parallel. The oil used in the treatment of the slime consists of about three to three and a half pounds of sludge acid kerosene per ton of slime treated and about two and a half to three pounds of wood creosote, and about 15 pounds of 60° Be. sulphuric acid per ton treated.

Q. 10. What is the capacity of the slime flotation plant?

A. The capacity is about 3000 tons.

Q. 11. What does the feed to that plant consist of?

A. The total feed consists of the current mill slime, which I have just described, plus a thousand tons, approximately of what we call dump slime. This dump or pond slime is slime which has been accumulated from the time the plant started in 1902—the original plant, and it has been accumulated in ponds and is now being returned for treatment by flotation.

Q. 12. Describe a little more in detail the concentrate de-watering plant.

A. The concentrate de-watering plant consists of three buildings, using 50x12 Dorr tanks of the standard type. The upper building, called No. 1, treats the concentrate produced in the main mill and delivers that to six tanks. The overflow from this building passes to what we call the No. 3 building, which contains 10 fifty foot tanks, and the overflow from this

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building passes to the ponds, as it still contains a small amount of concentrate which has not settled out. This concentrate is settled in the ponds, and is being brought back and will be subsequently brought back for treatment in the smelter. The slime flotation plant concentrate passes to the No. 2 de-watering building, which consists of five 50-foot tanks. The overflow of this building goes, with the No. 1 building overflow, to the No. 3 plant. The spigot discharges of all these tanks pass to 13—12 ft. I should say 11½ ft. diameter by 12 feet face Oliver filters. The filtrate water from these filters passes to the ponds, in order to save any concentrate it may contain, although it is practically clear water, while the cake passes on to a conveyor and is thence taken to the smelter for treatment.

Q. 13. What you have described thus far is the copper concentrator plant?

A. The copper concentrator plant.

Q. 14. There is also a zinc concentrator plant?

A. Yes, there is.

MR. KENYON: I will now offer in evidence the two flow sheets introduced by the witness.

Flow sheets admitted marked PLAINTIFF'S EXHIBITS Nos. 242 and 243.

Q. 15. Will you please describe the zinc concentrator?

A. I have here a flow sheet of the large zinc ore concentrator which will facilitate the description. This

concentrator is designed to treat 2,000 tons of ore per day.

Q. 16. State first when it was erected.

A. The erection was started in December of 1915 and completed in August of 1916, and the mill put into operation at that time.

Q. 17. And what ore does it treat?

A. It treats the zinc ore from the Butte mines, together with a small amount of custom ore from other districts. This concentrator was designed to treat 2000 tons of ore. The crushing division is a duplicate of the crushing division of the copper mill, the ore being crushed through two millimeters, and the only difference being that in the zinc ore concentrator there are no jigs or tables. The crushing division simply crushes the ore through 2 millimeters and delivers it to the grinding division.

Q. 18. There is no water concentration at all in the zinc concentrator?

A. There is no water concentration there. The grinding division consists of seven Hardinge mills, of which five are used. These mills are the same design as those used in the copper mill, 7½ feet in diameter, with six foot cylinders, using balls. The material is ground through approximately a .25 millimeter, and is then sent to the flotation division. The flotation division consists of six standard type Minerals Separation machines of the same design as those in the copper mill. The oil and acid is added ahead of the concentration machines. The following amounts of oil

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are used, these figures being the averages for January, 1917, and are fairly representative of our practice:

Sludge acid kerosene .7 pounds per ton of feed to the flotation division; wood creosote 2.7 pounds. This creosote at the present time is a mixture of Cleveland Cliff hardwood creosote, and a creosote which we are getting from either the Georgia Pine Turpentine Company or the Pensacola Company of Florida, a mixture of about half and half. The amount of sulphuric acid used is 22.7 pounds of 60° Be.

The overflow from the first spitzkasten of the six primary machines is a finished concentrate. The overflow from the next eight spitzkastens is what we call a rougher concentrate and goes to the two cleaner machines. These cleaner machines are the same type as the six roughing machines. The last five boxes make a middling which is returned to the primary machines. The spigot from the last box of the rougher machines is a final tailing and is sent to waste. The cleaner machine~~s~~ makes clean concentrate from the first seven boxes and a rougher concentrate from the last seven boxes which is returned to the feed of the cleaner machine~~s~~. The spigot from the last box of the cleaner machine is a middling which is returned to the feed of the rougher machine. The cleaner concentrate is settled in five fifty foot Dorr tanks, the overflow from these tanks being slightly muddy, is returned to the system as sluicing water. The spigot product is sent to an Oliver filter where it is dewatered, the cake going to the cars for shipment to the zinc plant and the

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filtrate being returned to the system. That briefly describes the zinc ore concentration.

MR. KENYON: The plaintiff puts in evidence flow sheet produced by the witness and the same is marked plaintiff's exhibit 244.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 244.

Q. 19. Will you please state now a little more in detail what is the practice with regard to returning middlings?

A. In the copper mill in the treatment of what we call the sand feed, which is a product from the grinding mills, we make a clean concentrate from the first seven boxes of the machine and from the last seven boxes we make a middling which is returned to the head of the system, of the flotation system. In the slime concentration we make a finished concentrate from the first 9 spitskasten and we return as middling to the head of the system the overflow from the last 5 spitzkasten. In the copper mill it will be noted that we use no cleaner machines at all. In the zinc concentrator we use cleaner machines, giving the concentrate one cleaning. The first machines or primary machines make a finished concentrate from the first spitzkasten, and the next eight spitzkasten make a rougher concentrate which goes to the cleaner machine and the last five spitzkasten make a middling which is returned to the feed to the primary machine, the spigot discharge from the last spitzkasten being a tailing. The cleaner

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machines make cleaner concentrate from the first eleven spitzkasten, and a rougher concentrate or middling product from the next 7 which is returned to the cleaner machines, and the spigot products from the last spitzkasten on the cleaner machine is returned to the primary machines and mixed with feed.

Q. 20. Do you ever take into account the oil contained in the returned middlings in determining the consumption of oil in the process?

A. We do not.

Q. 21. Why are middlings returned to the head of the same machine when they are so returned?

A. Why, the middling really acts as a safety, you might say, between the concentrate and tailing, much the same as in the operation of a table it is not feasible to make a clean-cut concentrate and a clean-cut tailing. The recovery will be higher by cutting out a portion in between which is a little too rich to go as a tailing and a little too ~~c~~lean to go as a concentrate and returning that to the feed, thus making a circulating load. And, for the same reason, we return middlings in the flotation process.

Q. 22. Does that return of middlings result in economy of oil in the total process so far as you have observed?

A. No.

Q. 23. In the matter of consumption of oil in the total process so far as you have observed, does it make any difference whether middlings are returned to the

head of the same machine or are returned to a cleaner machine?

A. I have observed that it makes no difference.

Q. 24. You have spoken of a round table plant having been scrapped as an incident in the installation of the copper concentrator. Can you give us from the records of the company the total value of the entire plant that was scrapped to make way for this installation?

A. Of the entire round table plant?

Q. 25. Yes.

MR. KREMER: We object to that as incompetent, irrelevant and immaterial and meeting no issue in the case.

THE COURT: It tends to show the displacement, the success of this system displacing others which seems to be a consideration. The objection will be overruled.

MR. KREMER: Exception.

A. I understand that you want the value of the round table plant displaced?

Q. 26. MR. KENYON: Of all the plant that was displaced and scrapped and made useless by the installation of the copper concentration plant?

A. The dismantled value of the round table plant which was displaced by the flotation after 21 months operation was $260,261.32. From this must be subtracted a value of $31,451.27 for the use of this building in the electrolytic zinc plant, leaving a net dismantled value of $228,810.05. The dismantled value of the main concentrator replaced by flotation, as it

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appears on the books of the company today is $630,-288.18, making a grand total, including the round table and the main copper mill of $859,098.23.

Q. 27. You have given, I believe, the oils, both as to character and quantity, that have been used in the flotation mill operations, both in the copper concentrator and in the zinc concentrator, have you?

A. I have given them approximately, yes, in my description.

Q. 28. Have you ever in your experience noticed or known as a fact that where the percentage of sulphide minerals in flotation feed increased the amount of oil had to be increased?

A. I have not.

Q. 29. Have you ever followed any such rule of practice?

A. We have not.

Q. 30. Have you figures that would illustrate the contrary of that?

A. I have here some figures made up from the month of January, 1917, showing the amount of oil used in the treatment of copper sand and of copper slime and of zinc ore. I might state here that in describing the copper mill I omitted to say that a certain amount of slime is returned to the main mill for treatment with the sand. All of the slime does not go to the slime plant. I also have the—

Q. 31. (Interrupting.) About what amount is returned approximately?

A. About one-third of the slime produced is returned to the main mill for treatment.

Q. 32. About one-third of the current slime?

A. About one-third of the current slime. The remaining two-thirds passes to the slime flotation plant. The total sulphide contained in the three products, that is the copper sand, the copper slime, and the zinc ore for the month of January, taken from our assay sheets is as follows: The copper sand contained 10.3 per cent total sulphide; the copper slime contained 12.8 per cent total sulphide; and the zinc ore contained 38.6 per cent total sulphide. The amount of oil used in the three cases was as follows: The copper sand, total oil, 3.5 pounds per ton of feed treated by flotation; copper slime 5.5 pounds; and the zinc ore 3.4 pounds. That is the zinc ore which contains very nearly four times as much total sulphide as the copper sand used one tenths of a pound less total oil per ton of ore treated. The amounts of acid used were as follows, based on 60° Be. sulphuric. Copper sand 6.8; copper slime 13.8 and zinc ore 22.7 per ton of ore treated by flotation.

Q. 33. Why did the copper slime require more oil than the copper sand?

A. I presume that it was due to the presence in the slime of considerably more aluminous clay material which probably absorbed the oil and I presume rendered it useless for flotation purposes.

Q. 34. Now as to the extent of use of this flotation process at the Anaconda mill, will you please as an example give us from the official records of the company

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the total tonnage fed to the copper concentrator for the year 1916, of ore for concentration treatment?

A. The total tonnage of copper ore treated during the year 1916 in the copper mill was 5,030,350 tons containing 296,112,514 pounds of copper.

Q. 35. And what percentage of that amount of copper was actually recovered by mill operations during that year?

A. There was actually recovered of this copper 95.448 per cent.

Q. 36. Now, as to the flotation part of the operation that year, leaving out the wet concentration operations of the upper part of the mill, what was the total feed to flotation from newly mined ore during 1916?

A. The total feed to flotation?

Q. 37. I refer to the copper concentrator of course.

A. The copper mill, the total feed to flotation in the copper mill during 1916 from newly mined ore was 3,800,750 tons.

Q. 38. The copper content of that tonnage?

A. Containing 106,339,156 pounds of copper.

Q. 39. And what was the tonnage of the concentrates recovered by the flotation plant?

A. The concentrate recovered by the flotation plant from this feed amounted to 576,417 tons containing 99,962,700 pounds of copper.

Q. 40. What was the percentage of recovery by that part of the plant, the flotation part?

A. The percentage of recovery of the flotation

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plant was 94 per cent of the copper contained in the feed to the flotation plant.

Q. 41. Now, as to the zinc concentrator, what was the total tonnage from the time the zinc concentrator started operation until the present time—I believe your figures are down to the present time, are they not?

A. Yes. The total ore treated by the zinc concentrator from the time the small concentrator started in January, 1916, up to April 1st of the present year was 292,493 tons, containing 78,308,337 pounds of zinc.

Q. 42. What was the recovery of the zinc in percentage of the zinc in the feed to the zinc concentrator?

A. The recovery of the zinc in the zinc concentrator during this period was 92.8 per cent.

Q. 43. What was the grade of that zinc?

A. Approximately 33 per cent zinc.

Q. 44. Will you tell us please what use is made of that concentrate, what value it has?

A. This concentrate is roasted and then treated with dilute sulphuric acid, the zinc going into solution and from the solution the zinc is later precipitated electrolytically.

Q. 45. What is then done—where is that done?

A. The roasting is done partly in Anaconda and partly in Great Falls. The leaching and electrolytic work is done entirely in Great Falls.

Q. 46. Has zinc of that grade any value for smelter purposes, ordinary smelter purposes?

A. I understand it has not.

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Q. 47. Its value then is dependent upon the electrolytic process by which the zinc is purified?

A. It is.

Q. 48. Prior to the installation of the flotation plant which you have described how was the concentration effected at the Anaconda mill?

A. You refer to the copper mill?

Q. 49. The copper mill, yes.

A. The concentration was effected entirely with jigs and tables, with a round table treatment of slimes coming in about 1914.

Q. 50. Entirely water concentration?

A. ~~The same thing.~~ Entirely water concentration

Q. 51. I believe, Mr. Wiggin, you have not given us the grade of the copper concentrate that is produced in the copper concentrator. Have you those figures for the year 1916?

A. You mean the total concentrate?

Q. 52. The total concentrate from the copper concentrating mill?

A. The total ~~mill~~ concentrate from the copper concentrating mill for the year 1916 had the following analysis: Per cent copper 8.072; ounces of silver per ton 5 ~~6~~.186; ounces of gold per ton .0168; per cent SiO2 22.8; per cent FeO 33.7; per cent sulphur 32.8; percentage Al203 5.2; CaO.2.

Q. 53. You say that the grade of the copper concentrate, so far as the copper is concerned, is 8.07?

A. Yes.

Q. 54. Is that a low grade?

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A. No, that is a grade of concentrate which is suitable for our smelter. It would be considered low copper in comparison with ores carrying less iron than the Anaconda ore carries. The Anaconda ore carries a great deal more iron than ores in Utah and Arizona for example. There the concentrate may run as high as 20 to 30 per cent copper, but the insoluble would be about the same as our insoluble. This concentrate is concentrate which is most suitable for smelting treatment at our plant. If we made it any cleaner it would be an expense to us to add silica to it. I might say that we could make any grade of concentrate we desired, that is up to a point where we eliminated all free silica.

Q. 55. You purposely seek to attain about the grade 8.07?

A. We do. I might explain that the grade is not based on the copper, it is based on the content in iron and insoluble, and the copper takes care of itself.

Q. 56. Will you now, from the original records of the company, let us know what the total tonnage of ore treated was from the time the mill was started until the 31st of December, 1915, which you say was by water concentration?

A. The Anaconda concentrator first started operations in February, 1902, and the total amount of ore treated from that time through December 31st, 1915, was as follows: 35,877,044 tons containing 2,408,629,436 pounds of copper.

Q. 57. Of this copper content, how much was actu-

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ally recovered by the processes of concentration that were actually employed?

A. There was actually recovered as concentrate through December 31st, 1915, 11,893,536 tons.

Q. 58. Translate it into pounds?

A. That is the tons of concentrate, containing one —containing 1,885,859,368 pounds of copper.

Q. 59. On December 31st, 1915, what had this water concentration process resulted in in the way of rejects then present and existent in the valley below the mill? Answer from the records of the company?

A. The sand tailings produced in the mill were piled just below in the valley and it is estimated that that pile contained on Dec. 31st, 1915, 17,000,000 tons of tailing, carrying .65 per cent copper, or a total of 221,000,000 pounds of copper. And in addition to that there had been saved a certain amount of slime from the mill before the round table plant was installed and it is estimated that the slime pile on the first of January, 1916, contained the following tonnage: 833,758 tons, containing 36,031,725 pounds of copper.

Q. 60. And are those the slime tailings that you are now treating in the slime plant at about the rate of one thousand tons per day.

A. They are.

Q. 61. Now, assume that through the years from 1902 until the 31st of December, 1915, on the tonnage that was actually treated at the mili by water concentration, from year to year, the processes actually operating in your copper concentrator during the year 1916.

and giving the recoveries then made had been applied and utilized, what would have been the additional recovery of copper from that tonnage over and above the recovery that was actually made, the figures of which you have given us?

MR. KREMER: To which we object for the reason that it is incompetent, irrelevant and immaterial for any purpose, as it would not even tend to prove that which counsel had offered it to prove, namely, utility. For the further reason that it has not been shown that the witness knows the various processes which have been conducted in the plant of the Anaconda Company since the plant started or since the first date mentioned, February 1st, 1902.

THE COURT: Well, it is merely another way of getting at what could be gotten out of those tailings by flotation: Perhaps he has given enough data already, but I think he can answer. The amount of weight it is entitled to is another question. Objection overruled.

Defendant excepted.

A. In answering your question I might say that in giving the total copper recovered by water concentration from the time the mill started in 1902 through December 31st, 1915, I gave the total pounds of copper that was recovered in the form of concentrate and treated in the smelter. I might add to that the amount of copper that had been recovered in the form of slime in the ponds and returned to the smelter for treatment, and also the amount of copper that had been recovered from the tailing pile by the leaching process up

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to January first, 1916, which will give a total recovery of copper up to that time of 1,945,977,851 pounds. Now, if we take the tonnage of ore treated during this period, which was 35,877,044 tons, containing 2,408,629,436 pounds of copper and apply to it the recovery which was actually made in our concentrator during the year 1916, the flotation process having been in full operation during the entire year—

Q. 62. What percentage?

A. A percentage of recovery of 95.448, which was the actual recovery for the year 1916—we would have recovered from this tonnage of ore containing the given amount of copper, 2,298,988,624 lbs. of copper, or an excess recovery if we had used the process of flotation which we now have during this entire period, over and above the recovery which we actually made, including what slime has been smelted and what tailing has already been leached—an excess recovery of 353,010,773 lbs. of copper.

Q. 63. What would have been the value of that copper at the average market price for copper current during that terms of years, figured with reference to the tonnage treated at the mill from year to year, less a reasonable charge for the cost of treatment?

A. If we determine the average price of copper for that period as applied to copper produced at Anaconda by taking the average yearly quotations from the Engineering and Mining Journal, which is considered a standard, and apply these yearly quotations to the pounds of copper treated during that year, and then

average the entire period, from 1902 to 1915 inclusive, we get an average price for copper of 14.8 cents per pound. If we deduct from this 4 cents to cover the treatment charge for smelting and converting, that leaves a net value of 10.8 cents per pound, and applying this value to the three hundred and fifty-three million pounds of copper which we would have recovered if we had had the flotation process in operation, gives a total value for this copper of $38,125,163.00.

Q. 64. Would that allowance for the cost of treatment be liberal?

A. I think four cents is a liberal allowance—that is four cents per pound of copper recovered is a liberal allowance for smelting and converting of the concentrate. I might say that the refining and marketing charge would be taken care of by the amount of silver which would have been recovered, and which we are neglecting in this calculation. That would amount to approximately 2 cents per pound of copper.

Q. 65. Now, you say that on January 1st, 1916, there was in the slime ponds as a reject of prior processes, according to the record of the company, 835,758 tons?

A. Yes.

Q. 66. Containing 2.16% of copper?

A. Yes.

Q. 67. Totaling 36,031,725 pounds of copper?

A. That is right.

Q. 68. Now, valuing that as an asset today from the point of view of its susceptibility to recovery of

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that copper by the flotation process at present practised in the mill, what would be a fair percentage of recovery attainable on those lines?

A. If we consider that these slimes at present contain some oxidized copper, having been exposed to the weather for a good many years, we can figure, I think, safely, a .5% copper tailing in the treatment of this slime. I might say that in the treatment of the current mill slime which has not been exposed to the weather our tailing averages around .25 to .30% copper, so I think .5 is a liberal allowance. And assuming that a 12% copper concentrate, with a feed running 2.16, which is the content of the slime, and calculating the recovery, we find that from this slime we will recover in the form of concentrates 28,800,000 pounds of copper. If we assume a 20 cent market for this copper (and I might say that part of this copper has been recovered during 1916 and so far in 1917 and the rest of it will be recovered in the next 20 months approximately so that probably 20 cents would be a fair market value for the copper, considering the fact that it has already sold above 30 cents for part of the period and if we subtract from 20 cents 6 cents a pound to cover the cost of treatment and smelting and converting and allow the silver content, which would amount to approximately 2 cents a pound, to take care of the refining and selling, that would leave us a value of 14 cents a pound for this copper. That would make the 28,800,000 lbs. of copper worth $4,032,000.

MR. KENYON: The witness is yours.

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CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 69. Mr. Wiggin, you gave some figures, I think, of January, 1917, on the amount of oil and acid relative to sulphide in the copper slime, copper sand and zinc mills. Was that with reference to January, 1917?

A. Yes, January, 1917.

X-Q. 70. Now, can you furnish a daily record for that month of the different plants, showing the amount of these different reagents and also the dilution of the pulp and the assay of heads, concentrate sand tailings, daily?

A. I can furnish a daily record of the amount of oil used, but I might explain that in this way: that the amount of oil used on each shift is determined by the operator—by what we call the reagent man, by making measurements in the reagent tanks. These measurements are not accurate; they are approximate. At the end of the month we average these different determinations, and compare them with the actual amounts of oil used as measured from the large storage tanks. Then we distribute the actual amount used between the copper sand and copper slime in proportion to the daily readings, and I would say that these daily readings do not check exactly the actual amounts used, as it is impossible to make an accurate reading in the reagents, but they do check fairly closely. The total amount of oil used from the large storage tanks is de-

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termined accurately, and the distribution is made in accordance with the daily shift readings of the reagent men.

X-Q. 71. You mean that the oil consumption shown by these daily readings does not check up with the actual amount of oil consumed as shown by the readings on the big tanks?

A. Not exactly, no.

X-Q. 72. How near?

A. Well, I have a month here; take this month of January, and consider the sludge, for instance, in the treatment of the sand in the concentrator. The average of the daily readings is 3.25. The average of the actual pounds, as calculated from the storage tanks and distributed in proportion to the average of the daily readings, is 3.37; 3.25 against 3.37. The creosote is .30 against .27.

X-Q. 73. Do you keep these shift figures so that you can produce them so that there would be a way of comparing the amount of oil used upon each day?

A. We keep these figures for one month back, and I am not sure whether I could get January or not. We have two copies made; one is sent to me and the other is kept by the operating superintendent, and we keep them for one month back. The reason we do not keep them longer is because they become too bulky.

X-Q. 74. These figures that you gave are monthly averages?

A. They are the actual monthly averages.

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X-Q. 75. Can you give those daily figures for an actual month?

A. I can give them for any month.

X-Q. 76. Those figures are the only ones that would enable any comparison to be made with reference to the relation of oil and acid to sulphide on the same ore from day to day, aren't they?

A. Well, you mean the daily readings are the only ones?

X-Q. 77. Yes; otherwise we would have to proceed with the monthly averages over a long period of time, wouldn't we?

A. Yes; but this month of January is typical. I am sure that any other month would show practically the same relation. I would be glad to get them if you desire.

X-Q. 78. Well, do that then, please.

A. What month would you like?

X-Q. 79. This month, last month, or the month before?

A. Just one other month?

X-Q. 80. Yes.

A. March or February?

X-Q. 81. March will do. And the assay of heads, tails and concentrates as to iron, copper and insoluble, in the case of the copper.

A. We do not determine all those things daily. I will tell you how we get those assays; the samples for each day are saved until the end of the month. The copper is determined daily, but the analysis is determ-

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ined once a month on the combined samples made up from the daily samples.

X-Q. 82. Well, you can give me the copper daily?

A. I can get the copper daily.

X-Q. 83. That will be the copper in the heads, tails and concentrates?

A. Yes, I can give you that daily.

X-Q. 84. And with those—will those figures show the dilution?

A. I don't know whether we keep the density of the pulp in the slimes plant now. We used to keep it, but I don't think we do now.

X-Q. 85. And in the sand plant?

A. I am not sure; I don't think we keep it now.

X-Q. 86. How about the zinc plant?

A. We don't keep that daily, I am sure; we have kept all those figures over different periods of time until they had served their purpose. The density in the slime concentrator varies a great deal, because we are treating the dump slime there, bringing back a thousand tons dry a day. The density in the sand plant varies very little. The density in the zinc concentrator varies considerably.

X-Q. 87. You have a leaching plant in operation, haven't you?

A. We have a copper leaching plant.

X-Q. 88. And was that in operation before flotation was introduced?

A. I will just make sure of that. The leaching plant was put into operation in May, 1915, and the first sec-

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tion of the concentrator remodeled for flotation was put into operation just about the same time, but I could not say exactly whether it was after or before.

X-Q. 89. The leaching plant is still operating?

A. It is still operating.

X-Q. 90. Efficiently?

A. Yes.

X-Q. 91. What material are you treating in the leaching plant?

A. The accumulated sand tailings.

X-Q. 92. The same material that is in the sand department of the flotation, the sand copper—

A. Well, it is not exactly the same material. The material that we treat by leaching is the 17 million tons referred to in my testimony as having been accumulated from the mill. It is a tailing made on jigs and tables in the old water concentration system.

X-Q. 93. And by leaching you are attacking these 17 million tons?

A. Yes.

X-Q. 94. By the way, what is stove oil; I forgot to ask you; it is a petroleum oil, isn't it?

A. I understand so, yes.

X-Q. 95. Is that one of the oils that you are using in flotation?

A. We don't use it now, no; we used it in the experimental work.

X-Q. 96. What are you using now?

A. We use sludge acid, kerosene and creosote oil. It is a hardwood creosote. We also use sulphuric

P. 4315, L. 30, after " sludge " insert " from the Standard Oil Company, we got a sludge "

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acid. In the treatment of the sand we sometimes use creosote and sometimes not. At the present time we are using nothing but sludge acid kerosene.

X-Q. 97. How about the zinc plant?

A. In the zinc plant we use creosote. We use nothing—we have used nothing but Cleveland Cliff creosote and sludge acid kerosene. At the present time we are using sludge acid kerosene and a mixture of Cleveland Cliff creosote and the creosote which we get from the Pensacola Company; it is their No. 350 oil, I think.

X-Q. 98. In the testing period that you have told about you used several different petroleum oils, stove oil and some others?

A. Yes, in the testing period we used several different forms of sludge acid, too, obtained from different refineries.

X-Q. 99. And these petroleum oils produced the result aimed at, didn't they?

A. No.

X-Q. 100. That is, notwithstanding that you have found others that you think better?

A. No, not all of them; some of them gave us very poor results.

X-Q. 101. Which ones gave fairly efficient results?

A. The only two sludges that gave good results were a sludge from the ~~United~~ Union Oil Company, and a sample that we obtained from the Standard Oil Company. T~~he latter,~~ When we tried to duplicate this latter sludge which gave us very poor results.

X-Q. 102. You referred to using—my note looks as

if it was crude oil. Did you ever use crude oil and stove oil?

A. I don't think we ever used crude oil. Fuel oil is sometimes called crude oil; we have tried that.

X-Q. 103. Argol, what is that?

A. That is a tartrate.

X-Q. 104. It is a chemical?

A. Yes.

X-Q. 105. Have you got any results which you obtained using stove oil and fuel oil, either alone or in a mixture?

A. Yes, we have all those results; I think those results were given in the paper I published in the A. I. M. E. If anyone has a copy of that here—

X-Q. 106. Here is a copy.

A. Well, this does not show it either, because this is a summarized account of our work, and in order to show the results we got in our first preliminary period I would have to go back to the original company records, which I can do. This paper shows results when using stove oil, but I might say that we never considered stove oil as a flotation oil—and we do not use it now and have not used it since the plant started on large operations.

X-Q. 107. When the middlings are sent to he cleaner or the rougher concentrate whatever it is called, do you add any extra oil to treat that in the cleaner?

A. No. You refer to the zinc concentrator?

X-Q. 108. Yes. Then how is it that the oil and middlings which are returned to the head of the rough-

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er machine have no effect in helping along flotation; I don't know that you put it just that way, but that was the impression I got.

A. I could not say whether it has any effect or not. We do not consider it in our computations of the amounts of oil used.

X-Q. 109. In fact you have no reason to segregate out the effect of the oil coming from this source, from the middlings, from the new oil; all you are concerned with is just how much oil you have to add?

A. We have no reason to segregate it and never have determined it.

RE-DIRECT EXAMINATION.

BY MR. KENYON:

R-Q. 110. Mr. Wiggin, this kerosene sludge or sludge acid kerosene as it has been variously called —is that kerosene?

A. No, that is a by-product from the refining of kerosene.

R-Q. 111. Does it contain kerosene?

A. It may contain a small amount of kerosene.

R-Q. 112. Not in any notable extent?

A. It certainly would not contain kerosene to any extent, because the refineries could not afford to lose their kerosene in that way. It is simply the impurities taken out of the kerosene, and it is sold at a very cheap price. We have never detected any kerosene in

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it, although we have detected a colorless liquid at times in some of the shipments, but I could not say what it was. It was not kerosene.

R-Q. 113. Is the solid feed to your copper flotation plant constant or is it variable in character?

A. It is quite constant; the only variation is due to the human element variation in ~~treating~~ feeding; that is we have men feeding the ore, to the mill, and there is a certain variation due to that.

R-Q. 114. This leaching plant that you have spoken of, it is a plant of considerable extent and cost?

A. Yes, it is a plant that will treat about 2500 tons of sand tailings a day by the leaching process.

R-Q. 115. What was it originally built for particularly?

A. It was built originally to treat the sand tailings as produced from the mill the current tailings.

R-Q. 116. About how long before the M. S. flotation process?

A. The testing work and the idea of building the plant all came before we tested flotation.

R-Q. 117. And when flotation was tested it was substituted ~~submitted~~ as the process~~,~~ and the plant for treating the current mill tailings, was it?

A. It was.

R-Q. 118. And this leaching plant was diverted to the purpose that you have mentioned?

A. It was.

R-Q. 119. Now, one more matter. You have

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spoken of a round table plant. Did that involve an invention of your own?

A. Well, partly, yes. The patent for the round table is partly in my name.

R-Q. 120. You were a joint inventor with someone else?

A. I was.

R-Q. 121. And it was patented?

A. It was patented.

R-Q. 122. And was it better or worse than prior water concentration processes?

A. It was better than any other machine we tried, and we tried, I think, all the modern slime concentrators.

R-Q. 123. And had you hopes of reward and perhaps wealth from that invention?

A. I had some hopes until flotation came along.

R-Q. 124. What did flotation do to it?

A. It put it out of business practically. The best we could do on the slime with the round table was about a 1.1 of Cu. tailings, and in our experiment with the flotation process, we got tailings as low as .15, and we are at present making tailings running around .3 from the current slime, and in one month the tailing ran as low as .23 when treating slime.

R-Q. 125. Was this round table invention installed anywhere else, or used anywhere else?

A. It was not.

R-Q. 126. Was it about to be at that time?

A. We were just starting to put the table on the market when flotation became known through this part of the country and was being adopted.

R-Q. 127. And you then desisted from that effort?

A. We did, yes.

WITNESS EXCUSED.

WILLIAM MASON GROSVENOR, resumed the stand, testified as follows:

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 176. There was some uncertainty in my mind as to the meaning of your testimony relative to the effectiveness of a single adsorption layer in producing attachment and flotation. Will you explain this more fully?

A. If, as I understand it, a single adsorption layer would appear at—let us say the interface between the pulp and the bubble—if there were only such a layer, or, to put it in another way, if the layer were only of the thickness that would be regarded as a single adsorption layer, the effect would in my opinion be substantial ly direct attachment to the air in the sense that such a single layer would be formed I think, not with oil—that is speaking of oil as I defined it, an insoluble matter. With the insoluble matter, it is my conception that there must necessarily be two adsorption layers, that the oil must have on the one side of it the

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air, on the other side of the aqueous pulp, and that those two interfaces each, in every definition which has been used by the experts for the defense, must be regarded as an adsorption layer. Then if now we assume the amount of oil to be increased beyond the mere presence of these two layers, we get the slight amount of oil in bulk as distinguished from layer oil present between these two layers, and that it is more or less free to move about the bubble as described by Prof. Bancroft, seeking one portion or another of the bubble, moving between these two layers. In my cross examination I may have spoken of the effect of an adsorption layer on promoting attachment. I understood the question then to be the effect in promoting the coming of a mineral into the interface, whether it is a single or a double interface. I do not disagree with the statement that the presence of such a layer promotes readiness of attachment, merely that it decreases the force of such attachment. Speaking of the amount of oil, I feel that the presence of oil between these two interfaces (permitting this movement of oil around the bubble) may be so small as to be negligible, so far as accumulating a mass of material on one side of the bubble is concerned. And the point of necking out of which I have spoken, is the point where that amount of oil in bulk between these two layers becomes sufficient to permit the outer layer to be separated so far from the inner layer that a strain upon the particle (owing

to the sudden movement of the bubble), permits the oil to neck outward and draw off into a thick neck, which has relatively as indicated in my testimony on direct, perhaps five miligrams of attachment power as compared with 30 or 40. Does that make it intelligible?

R-Q. 177. The 30 or 40 mm. being applicable to what condition?

A. To the condition where there was in the case of 30 substantially no excess of oil between the layer: and in the case of 40 substantially no oil at all.

WITNESS EXCUSED.

IRA L. GRENINGER, recalled, testified as follows:

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. Mr. Greninger, on April 29th, 1917, you were one of a party representing the plaintiffs here who visited the defendant's mill?

A. I was.

Q. 2. And on that day you inspected the process there in operation?

A. I did.

Q. 3. Will you please describe that process as you saw it and briefly what you observed with respect to it?

A. I think the flow sheet has already been proved by the defendant's witnesses.

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Q. 4. What is the exhibit number?

A. Defendant's exhibit 222. On the day that we inspected the plant I found the flotation feed after having passed from the wet concentration section of the mill, was reground and divided into seven cuts each one of the seven portions going to one of the machines heretofore referred to as pyramid machines or roughers. These machines produced a rougher concentrate on the first three spitzkasten, which was quite slimy and apparently very low grade for a zinc concentrate; and this concentrate was retreated on the first of the retreaters which is marked on this exhibit "No. 1 cleaner." The tails from these machines were returned to the roughers or the elevator which distributed the original feed and the middlings to the roughers. The concentrate from this first cleaner was retreated in the second cleaner which is one of the pyramid machines which is marked on this exhibit "No. 2 cleaner." I think the first three spitzkastens of this machine, that is the product from the first three spitzkastens, was carried to the third and final cleaner which produced finished concentrate, the fourth, fifth and sixth and seventh spitzkasten on each of the pyramid machines produced a middling, the water level being very high in these spitzkasten, and a great amount of gangue slime was carried over with the mineral and was returned to the head of the pyramid machine or roughers.

Q. 5. What was the effect of a very high level of water in these last four spitzkasten?

A. It carried a very large portion—it in any case or all cases where such a level is maintained, carries a large portion of gangue slimes, that is the finer particles of gangue and clayey material that was contained in the ore, back to the original feed where it would be mixed with the new feed. Finer particles of gangue, slime and the clay floating near the surface of the water would be carried over and go back with the middlings. Anything floating near the surface of the water would go over under those conditions. This overflow of gangue slimes would be still further increased by tailings returned from each of the cleaners and the overflow from the final treatment of the ore which was had in a set of Callow cells. The concentrate from this Callow cell which was undoubtedly very low in grade, although I do not know the grade, would also carry a large percentage of gangue slimes which was also returned to the head of the rougher machines. Does that wholly answer your question?

Q. 6. You say that there was a very large quantity of middlings. In comparison with what was the quantity very large?

A. In comparison with the total of new feed, and was apparently by the amounts carried over, especially by the spitzkasten of the pyramid roughers, that is the 4th, 5th, 6th and 7th spitzkasten.

Q. 7. Enumerate again if you will the several sources of the middlings returned as the plant was operated that day?

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A. The 4th, 5th, 6th and 7th spitzkasten of each pyramid rougher.

Q. 8. Of each one of one to seven?

A. Yes, of each one of one to seven, the tails from each of the cleaners and the overflow from the Callow cells, where the tailings from the pyramid machines received their final treatment.

Q. 9. The finer parts of the gangue, the finer and lighter parts of the gangue, the clays for example, in the gangue, clays of the pulp would have a tendency to accumulate in this returned feed circuit, would they?

A. I think they would have a tendency to build up to an extent far in excess of the amount of such material carried in the original ore.

Q. 10. Had you any means of judging of the relative quantity of returned middlings fed to the head of the machine as compared with the new feed to the head of the machine?

A. Not visually.

Q. 11. Was it an unusually large quantity?

A. That is I mean by that, not where the two streams joined, I didn't see that where the two streams joined. The quantity was unusually large by observing them at their sources—That is where they left the spitzkasten, but a comparison of the two streams where they joined, I did not see. I did not see them at that point.

Q. 12. As compared with standard M. S. practice

with which you have been familiar was the amount of that return middling large?

A. Yes, very much larger than ever I had seen used in my experience.

Q. 13. Very much larger than any you have ever seen used?

A. Yes.

Q. 14. Now please describe the concentrate that came over from the first spitzkasten of the first cleaner machine to each rougher machine from the point of view of your knowledge and experience of standard Minerals Separation practice?

A. The concentrate was a mineral froth, I would say a typical froth of the patent in suit, with indications of a degree of over-oiling, the degree of over-oiling did not seem so marked as I would have expected knowing the condition of oiling at that time and knowing the amount of oil being introduced into the plant.

Q. 15. What were these conditions of over-oiling?

A. Well I think the records show that the amount of oil added to the ore per ton on that day was something like 26 pounds.

Q. 16. And what were these indications of over-oiling that you speak of observing?

A. It was a sort of glassy appearing film on the concentrate—that is on the froth as a whole.

Q. 17. How did the consecutive froths compare with one another in that regard, the first, second and third of each rougher machine?

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A. The first, second and third were very much alike to my recollection. Of course after the third spitzkasten had been passed the conditions were altogether different in the fourth. There was no chance for comparison between those two, between the third and fourth?

Q. 18. Now, how did the appearance and character of the froth in the 4th, 5th, 6th and 7th spitz kastens appear with that in the 1st, 2nd and 3rd of the rougher machine?

A. The froth in passing off so fast in such a great volume of water did not give time for it to accumulate in any way that would make it possible to compare the two, where the froth was formed. It seemed very low grade and whitish in appearance, and was carried over, as I stated before, with a large amount of water.

Q. 19. From your observation of the process as practiced in the mill that day and the experience you have had with standard Minerals Separation practices, what is your opinion as to the identify or non-identity of the two processes?

A. I consider the process was that of the patent in suit.

Q. 20. You regard the two processes as substantially identical?

A. I do.

Q. 21. And the results you observed on that day as compared with the results with which you are

familiar in standard Minerals Separation practice, how do they compare? Were they substantially the same in kind or substantially different in kind?

A. Substantially the same in kind although the grade of zinc in the final concentrate was not what one would expect from the first class practice but was combined with a vast amount of slime which was returned in all cases. While some of this slime is dispensed with it cannot all be thrown out and some of it is bound to go with the concentrate, making a low grade zinc concentrate.

Q. 22. From your observation on that day is it your opinion that these results were inferior or superior to the Standard Minerals Separation practice metallurgically?

A. They were inferior.

Q. 23. How would you explain the fact that any metallurgical result at all was obtained in that process on that day with the amount of oil that was used?

A. First, by the absorption of oil by the vast amount of gangue slime returned into the circuit and second by the fact that when you consider the large proportion of the oil to have been absolutely useless to obtain any effect, either good or bad, in flotation. A portion of the oil was of a nature that caused it to congeal on being added to water of the ordinary temperature, that I think being the paraffin portion of the mineral oil which to my mind would make it

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useless in the matter of oiling mineral, and I do not think it would have any harmful effect. It would be rather neutral.

Q. 24. Has it been your experience that oil congealed in that way is useless for the purpose of flotation?

A. I can only base my answer on the appearance of this material in the water and after having solidified as it does, I don't consider that it could be of any use.

Q. 25. You took a series of samples on that day, I understand?

A. We did.

Q. 26. Or rather a series of samples were taken?

A. Yes.

Q. 27. You haven't yourself personally analyzed any of them?

A. I have not.

Q. 28. That has been for others to do?

A. They have been analyzed by others.

Q. 29. Did you have to do personally with the taking of those samples?

A. Of a number of them, yes.

Q. 30. And what was done with those samples?

A. Duplicate samples were taken to be retained by each side and they were sealed—at least those retained by the Minerals Separation staff were sealed at the plant under the inspection of the Butte & Superior gentlemen and they were transported to the

Minerals Separation laboratory in the city of Butte where they have since been in the custody of Dr. McIlhiney.

Q. 31. Do you recall what samples were taken or what samples were taken of?

A. Samples were taken of the new feed as it left the grinding mill, of the oil then being added, of the various other reagents including sulphuric acid and the copper sulphate in solution, the feed to the plant after having passed through the elevator at which time it had been combined with the return middlings. Then there were samples of the rougher concentrates from machines 5 and 6, I think, the pyramid machines—yes, pyramid machines 5 and 6, also the middlings from these same machines and general concentrate and general tails samples. There might have been others that I overlooked but that is all I can recall now. There were other samples. There was a sample of original ore taken at the shaft before going into the crushing plant, and a sample of the crushed ore taken at the tripper just above the fine ore bin, also a sample of the underflow from several Dorr thickeners which were handling the overflow from various machines in the wet concentrat~~e~~ion section, the underflow from these Dorr thickeners also having been merged with the other flotation feed.

Q. 32. Have you had experience in the absorption of oil by ~~clear~~ clay gangue slimes? Do you know that oil is absorbed?

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A. I know by tests that the oil is absorbed by that particular gangue slime and I have seen the same phenomena in other places to an extent, but as I never tried anything on as extensive a scale as this was tried I have no other parallel experience.

Q. 33. But you have known of this phenomena in other places?

A. I have known of it in a general way, yes.

Q. 34. Where was the oil fed into the system that day?

A. At the discharge of the tube mill which is designated by the officials at the mill as No. 1 in section No. 2, at the discharge of that mill.

Q. 35. Was the oil in the feed tanks warmed or heated, did it have the appearance of warmed or heated oil?

A. I think it was heated to an extent. I did not test the degree of heat.

Q. 36. Was the water of the pulp circulating through the system warm or cold?

A. I think it was about at the temperature of the atmosphere at that time.

Q. 37. You observed that the oil used on that day contained a considerable proportion of Jones fuel oil. What sort of oil is that?

A. It is a mineral oil.

Q. 38. As to whether it is a paraffin or a waxy base?

A. It is a paraffin base oil.

Q. 39. It is?

A. Yes.

Q. 40. And how does it behave in cold water?

A. The portion which I take to be the paraffin portion seems to coagulate and form a wax like material.

Q. 41. Forms a semi solid substance?

A. It does, yes.

Q. 42. It does not flow?

A. No, not after being added to the water. It seems to coagulate and seems to be in a sort of semi-solid state.

Q. 43. From your experience would you consider that oil in that state or condition would be useful in flotation?

A. I would not.

Q. 44. Would you consider it to be harmful in flotation?

A. I do not see that it could be harmful. I don't understand what harm it could do.

Q. 45. You were one of the parties, were you, who on behalf of the plaintiff visited the Magna flotation plant of the Utah Copper Company on April 21, 1917?

A. I was.

Q. 46. And you inspected that plant which was operating on that day?

A. I did.

Q. 47. Between what hours?

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A. From about twelve o'clock noon until seven P. M. in the evening of that day.

Q. 48. Will you please briefly describe the process that you saw in operation?

A. They were at that time treating by flotation a product known as their vanner concentrate. This material was classified and a portion of the underflow and the overflow from these classifiers was sent to Dorr thickeners where it was thickened, the underflow from the thickener going to a sludge tank and thence to an emulsifier at the head of the flotation machine proper and the overflow from these Dorr thickeners was sent back to the mill circuit. The machine consisted of two emulsifiers, Janney machines without spitzkastens, followed by as I remember it 17 Janney cells, double spitzkasten.

MR. KENYON: At this time I offer this flow sheet in evidence as plaintiff's exhibit.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 245.

MR. KENYON: Q. What is the flow sheet I now show you?

A. It is a flow sheet of the Magna plant.

Q. 49. Flotation plant at the Magna plant of the Utah Copper Company?

A. Yes.

Q. 50. Please comprehensively describe the process from this flow sheet as you saw it that day?

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A. This sheet commences with the Dorr tank. That is as marked "Dorr tank" on this exhibit. The flow from that is to the sludge tank, which is so marked. From the sludge tank the flow passes to two emulsifiers and from the emulsifiers to the feed end of the flotation machine proper. At the time of our visit concentrate was being produced on the first six cells, that is the double spitzkasten of the first six machines, finished concentrate—while a middling was being produced on the remainder of the machines in series, these middlings being returned to the sludge tank. Oil was added after having left the sludge tank, also at the same point, what is described as Calura. The first spitzkasten produced concentrate intermittently. The concentrate in the first spitzkasten, or the float in the first spitzkasten was very oily, largely an oil emulsion. In separating it on vanner or batea, it was easily divided into two separate and distinct products, one being an oily emulsion containing little or no mineral and globules of oil, the other product being the mineral froth.

Q. 51. You say it could be separated?

A. It could be separated.

Q. 52. How?

A. By shaking in an ordinary pan or batea. This froth on analysis contained 26.1% oil, and while it

P. 4335, L. 17, after " arrival " insert " at the plant before lunch. After that it only overflowed "

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A. Of the solids contained in that same froth. The next spitzkasten produced a froth which had less the effect of an emulsion, although it was still quite oily, and the concentrate produced by that spitzkasten carried just under 5% of oil of the solids contained; to be accurate I think it was 4.81%.

Q. 54. Going back to the figure 26.1 per cent of oil, what was it that showed that percentage of oil?

A. The concentrate; the sample taken of this particular froth.

Q. 55. You said of spitzkasten No. 1?

A. Yes.

Q. 56. The total overflow of spitzkasten No. 1?

A. At the time the sample was taken it was not overflowing. The spitzkasten was overflowing on our arrival intermittently, and at the particular time that this sample was taken, it was dipped from the froth on the surface of the spitzkasten, if I am not mistaken.

Q. 57. But it was the total float on the surface of the first spitzkasten?

A. Of the surface of the first spitzkasten at the time the sample was taken.

Q. 58. And this that showed 4.81% of oil, what was that?

A. It had more the appearance of a true froth.

Q. 59. What was it that showed that much oil?

A. Spitzkasten No. 2. The ~~only~~ way that sample was taken, it amounted to a cut of the entire product of it for a very brief period of time.

Q. 61. Was it the total overflow of spitzkasten No. 2 which showed that second proportion of oil?

A. 4.81 per cent, yes. Proceeding from there down toward the middling part of the machine, the concentrate assumed a more normal aspect, and the largest amount being delivered by any spitzkasten was reached at the fourth machine.

Q. 62. Spitzkasten No. 4?

A. Spitzkasten No. 4.

Q. 63. Please enlarge a little on that.

A. This froth had assumed a normal aspect.

Q. 64. What do you mean by normal?

A. It had lost this extremely over-oiled condition; while there was still evidence of over oiling, it was not the extreme over oiling which one noticed on the first and second spitzkasten.

Q. 65. The more normal froth, the mineral froth that you had been accustomed to see in the flotation process?

A. Approaching very closely to it.

Q. 66. What was it on No. 4?

A. The maximum was produced, was obtained by spitzkasten No. 4. No. 5 and No. 6 were about the same amount; that amount, of course, as far as I know, has not been accurately weighed; anyway I have not the figures.

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Q. 67. About the same amount, was it, in spitzkasten 5 and 6?

A. I think it was slightly less on those.

Q. 68. As compared with No. 4?

A. It didn't exhibit such evidence of over oiling as I proceeded towards the middling end of the machine. From spitzkasten No. 6 the product from the rest of the spitzkasten was all returned as middlings, from 7 to 17 inclusive.

Q. 69. And what was the character of the froth overflowing from spitzkasten No. 7, for example?

A. Here we again have the oil getting low, although with a high level of the water in the spitzkasten, which brings up the material, and the material had the appearance of froth. The froth was rather light and watery in appearance, while it contained some mineral, not the marked amount which accumulated on the other spitzkasten, due to the fact that on the concentrate spitzkasten the froth is removed mechanically, and the level is maintained somewhat below the lip of the spitzkasten.

Q. 70. On spitzkasten 1 to 6 where was the level of the water maintained?

A. Somewhat below the level of the lip of the spitzkasten, as the froth extended some inches below the top of the spitzkasten, and was raked off by mechanical paddles, or the like.

Q. 71. Spitzkasten 1 to 6 had mechanical means for raking off the froth into the launder?

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A. Yes, and for the middlings it was allowed to run over more freely.

Q. 72. No. 7 to 17, did they have mechanical means of scraping off the froth?

A. I am not clear as to that now; I think perhaps they were provided with such a device, but they were less useful, for the level was maintained higher, and more water was passing over, and consequently there was no great occasion for raking off the froth.

Q. 73. How about the amount of water overflowing from spitzkasten 7 to 17?

A. There was no great amount of water. The levels were practically close to the top of the spitzkasten; not a vast amount of any material.

Q. 74. A thin sheet of water?

A. A thin sheet of watery froth; I could not say there was any clear water coming over but a thin sheet of watery froth passing over.

Q. 75. What was the appearance of the average overflow from spitzkasten No. 7 as to over oiling?

A. There were patches of what appeared to be either free oil or vastly over-oiled mineral; very small amounts of course. At different points on these spitzkasten from the 7 down to the 10, part of the surface would be white watery looking froth, while other parts would be carrying mineral, which appeared to be vastly over oiled, or almost an oil emulsion.

Q. 76. What patches of those?

A. Patches of these would accumulate. The amount

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so produced could not be large, but there was such an appearance on those spitzkasten.

Q. 77. This watery froth that you have described as overflowing in spitzkasten 7 to 17 was a normal middling froth or middling concentrate?

A. Well, it was rather excessive, based on my past experience.

Q. 78. Excessive in what direction?

A. In the number of machines sending middlings back, and the amount of middlings being passed from them.

Q. 79. That was large?

A. It was large compared to what I have seen in my experience, and what I have done.

Q. 80. And the character of the froth as compared with the middling concentrate that you are familiar with in standard practice?

A. Barring those patchy appearances of over oiled material, it was very much the same as one would get in running the middling off rather rapidly, and not giving it a chance to accumulate on the spitzkasten.

Q. 81. These descriptive legends on the flow sheets, are they all accurate descriptions of the parts to which they relate?

A. According to my memory they are all correct. There was one mistake here in the overflow from the Dorr thickener, which was marked "to waste" which I see here has been corrected and marked "to circuit."

Q. 82. Have you any other comments to make on what you observed that day as to this process?

A. I think not.

Q. 83. What is your opinion as one practically experienced in the standard practice of the plaintiff as to the substantial identity or non-identity of this process that you saw on April 21st at this mill with the standard Minerals Separation process? Is it the same process or a different process?

A. I consider it the same process.

Q. 84. Would you regard it as as good flotation metallurgically as the standard Minerals Separation practice with which you are familiar?

A. I would not.

Q. 85. Why?

A. On account of the vast amount of oil that was being used, and its ill effect on the handling of the concentrate, as well as its excessive cost.

Q. 86. How do you account for the fact that any metallurgical result at all was obtained with the quantity of oil there used?

A. There was a factor entering into this work with which I am not familiar. I do not know what its effect would be; I never have used it in any way and never have tested it.

Q. 87. What is that?

A. That is the addition of this so-called calura, and as to what it is for or what its effect was, I could not say. I have not made any experiments with that material.

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Q. 88. You have had no experience with it?

A. I have not.

Q. 89. In practical flotation processes?

A. Not with this particular material, no.

Q. 90. I presume you were informed what oils they were using there?

A. Yes, we were told as to what the mixture was.

Q. 91. Do you recall what you were told?

A. As I remember it we were told that the oil was made up of 50% Jones oil, which has been referred to in this trial heretofore, 37½%, as I remember, of a particular fuel oil which has a definite name; I have it in my notes there, but I have forgotten what it is.

Q. 92. Do you want to look at your notes?

A. If you please. 37½% Lyoth fuel; 12% Amerıcan creosote and one-half of one per cent pine oil.

Q. 93. Was this Jones oil the same that you have spoken of in connection with the Butte & Superior operation?

A. I understand it to be.

Q. 94. Did you take samples and specimens that day?

A. We did.

Q. 95. State where you took them.

A. We took samples of the mill circuit water, the overflow from the Dorr thickener, the new feed to the flotation plant, and of that was also taken a time or tonnage sample; a sample of the circulating mid-

dling, and also a tonnage sample of that product; samples of the oil, and a time sample of the oil; samples of the calura, so-called, and a sample of the concentrate from the general concentrate after the product from the various spitzkasten had been intermingled, and several samples from spitzkasten 1, 2, 3, 4, 5, and 6, those producing the finished concentrate, and two other samples from spitzkasten No. 10, producing middlings, and a sample of the general tails; I think that covers the list.

Q. 96. What did you do with those samples?

A. Those samples were kept in our personal possession until we returned to Butte, when they were delivered to the laboratory of Minerals Separation corporation, and since then they have been in the custody of Dr. McIlhiney.

Q. 97. Have you ever, in all your experience in flotation, considered or figured or taken into account the oil that is theoretically being returned with the middlings to the head of the machine as a part of the oil supply of the machine?

A. I never have.

Q. 98. Why not?

A. I never considered it as an element influencing extraction one way or the other. If I have had a middling containing some oil, which I suppose it did —I have made extensive experiments to determine whether or not the returning of the middling affected extraction; that is, being returned to the same machine in which the middling was produced. I have ex-

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perimented with that matter by returning the product of from one spitzkasten up to seven out of eight, and I could detect no difference whatever as to extraction; there was no difference caused by these changes. Having made those tests and determined that, I have disregarded it as an element controlling or governing extraction. I have made the return of the middling only for the purpose of bringing the grade of the total product produced up to a given figure or up to the highest figure possible in a given plant.

Q. 99. You never regarded it as an oil-saving operation to return middlings to the head of the same machine?

A. I never have looked upon it from that light or considered it from that standpoint.

Q. 100. Have you ever observed or found that less oil need be fed—less new oil—to a machine in which middlings are returned to the head of the same machine?

A. Not in my experience.

Q. 101. Then what has your experience led you to conclude as to that?

A. That the oil contained in such middling, if oil there was, had no effect whatever one way or the other as far as regards extraction.

MR. KENYON: The witness is yours.

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CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 102. I think you said that the concentrate of No. 1 machine at Magna contained 26% of oil?

A. 26.1.

X-Q. 103. Did you say that that concentrate was produced by the process of the patent here in suit; do you remember whether you did or not?

A. I don't think I referred to that particular spitzkasten.

X-Q. 104. Let us refer to it now.

A. I considered it was the entire operation which was an operation of the patent in suit.

X-Q. 105. Of that first unit?

A. The operation taken together.

X-Q. 106. The first cell; did you say the first cell?

A. Not taken distinctly and individually, no.

X-Q. 107. Well, I understood that this concentrate containing 26.1% of oil came off from the first cell?

A. It did, yes.

X-Q. 108. And my question was whether that operation in that first cell was the practice of the process of the patent in suit.

A. If the action had stopped at that point, I would not consider it so, no.

X-Q. 109. So you don't think that the process of the patent in suit was practised in that first cell?

MR. WILLIAMS: I object to that. Are you going to ask the witness for a legal opinion?

MR. SCOTT: He was asked whether the process used there was not the process of the patent in suit and of the Butte & Superior.

MR. WILLIAMS: The mere fact that he happened to use that name—

MR. SCOTT: He used the name seriously.

MR. WILLIAMS: The mere fact that he happened to use the name when he named the process is no reason for cross examining him as to the patent in suit.

THE COURT: I don't understand why. He testified explicitly that in his judgment this was the plaintiff's process, except that it was practised using an excess of oil. The objection will be overruled.

Plaintiff excepted.

X-Q. 110. (Last question read as follows: Q. So you don't think that the process of the patent in suit was practised in that first cell?")

A. If the process had ceased at that point, I would not consider it the process of the patent in suit.

X-Q. 111. You mean what went on in that particular cell was not the process of the patent in suit?

A. I would not look upon it as such.

X-Q. 112. Well, what were the distinguishing features of this froth in this first cell that leads you to that conclusion?

A. This oil emulsion which was present in the cell.

X-Q. 113. What oil emulsion?

A. Well, I have heretofore described it on direct examination.

X-Q. 114. Describe what the difference is between it and something else, which comes under the patent in suit?

A. It was an agglomeration of oil globules, with little or no mineral; the operation did not separate out the mineral or form a froth.

X-Q. 115. Were there any bubbles in it?

A. There were oil globules; no bubbles that I could distinguish.

X-Q. 116. No air at all?

A. There might have been some entrapped air, yes.

X-Q. 117. Did you look to see?

A. I examined it carefully, and no doubt I saw some entrapped air in this emulsion.

X-Q. 118. What is entrapped air; did you see any air bubbles?

A. I can not definitely recollect having seen a particular air bubble in the froth, at the present time.

X-Q. 119. Can't you remember what you saw, a week ago?

A. I say I can not remember having seen air bubbles in the froth.

X-Q. 120. Have you seen them, and do you think you have forgotten it, or are you in doubt whether you saw them at all or not? Those are two different things, to forget a thing and not to know it.

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A. As I remember there were globules of oil; but as to whether or not there was air, I can not positively say.

X-Q. 121. Then you are prepared to say this was or was not the process of the patent in suit without knowing anything about whether there was any air there or not? Is that the idea? You say you are not sure about the air and yet you are giving us a positive statement as to whether it was the process of the patent in suit or not. It doesn't make any difference about air? Is that the idea?

A. This particular froth as I said was made up of such material that it did not resemble until it was divided any froth that I have seen produced anywhere.

X-Q. 122. What is a froth?

A. What is a froth?

X-Q. 123. Yes.

A. We understand it as being made up of air and mineral and a small amount of oil.

X-Q. 124. This was a froth that you saw but wasn't your particular froth. Well, what was the difference?

A. The vast amount of oil present was the greatest difference.

X-Q. 125. The amount of oil?

A. Yes.

X-Q. 126. How about cell No. 2?

A. Cell No. 2 was approaching the normal froth.

X-Q. 127. Had it got there?

A. I think it had.

X-Q. 128. You do?

A. I do.

X-Q. 129. And you said that that concentrate had in it 4.81 per cent of oil, didn't you?

A. It had.

X-Q. 130. How about the other cells? Was there a No. 3? I didn't hear anything about that?

A. No. 3 carried less oil than No. 2.

X-Q. 131. Carried less oil?

A. Yes.

X-Q. 132. That you consider was a real froth?

A. I certainly do.

X-Q. 133. Or some other kind of a froth?

A. I consider it a real froth.

X-Q. 134. Well now, referring to what you saw at the Butte & Superior Company on the 29th of April, I notice according to this report in evidence the rougher concentrate from the first spitz box went to the cleaner cell carrying 2.77 per cent of oil and was cleaned in the cleaner. Was that the process of the patent in suit?

A. I consider it so, yes.

X-Q. 135. It was?

A. Yes.

X-Q. 136. Well, now, that material carried over forty pounds of oil and was cleaned with that amount of oil, forty pounds per ton, that was practicing the process of the patent in suit, was it?

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A. I consider the operation in the Butte & Superior plant on that day the practice of the patent in suit.

X-Q. 137. What is that?

A. I said that I considered the operation in the Butte & Superior plant that day—

X-Q. 138. You consider they are the patent in suit no matter how much oil there was anywhere, is that the idea?

A. It depends somewhat on circumstances.

X-Q. 139. If there is no exception to it we might as well clear that up and stop asking questions about it. Did you see anything at all there that you did not consider the process of the patent in suit?

A. I did not.

X-Q. 140. You did not agree with Dr. Grosvenor in his statement that solid grease will function in this flotation plant either magnificently or maliciously, do you?

A. I don't know whether Dr. Grosvenor made such a statement.

X-Q. 141. Well, do you believe that solid grease will not function either to advantage or disadvantage?

A. It would depend on the particular circumstances and what particular grease was refererd to.

X-Q. 142. Well, the mere fact of its being solid you don't think would remove it from the sphere of action, do you?

A. After having experimented with it, I consider that it will.

X-Q. 143. That it will remove it from the sphere of action?

A. Yes.

X-Q. 144. That is what I understood you to say. What was it that you say oiled—did you say absorbed by gangue slime?

A. I think I said so, yes.

X-Q. 145. Where was it you saw that besides what you say you saw at the Butte & Superior?

A. At the Inspiration property, principally.

X-Q. 146. Do you know anything about the relation of fine material in the middlings that were returned to the Butte & Superior, to the proportion of fine material in the original feed?

A. Only by observing the conditions where they were visible and knowing that the fines will go over in all conditions where a large overflow of water is maintained.

X-Q. 147. You just guessed at that, didn't you?

A. I think it is somewhat more than a guess.

X-Q. 148. You feel pretty sure of it, do you?

A. I feel absolutely sure of it.

X-Q. 149. You think you are a pretty good judge of that sort of thing just by looking at it?

A. I consider myself so.

X-Q. 150. Where did you learn that there was Jones oil and Jones fuel oil being used at the Butte & Superior the day you were there?

A. It seems to me I heard it stated by Mr. Dosenbach on the witness stand.

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X-Q. 151. You may have misunderstood him, may you not?

A. There are so many kinds of these Jones products I might have misunderstood him.

X-Q. 152. You are not very certain about it are you?

A. Well, naturally my information is from other parties; I didn't put the oil in myself.

X-Q. 153. What temperature will the solid matter coagulate out of the Jones fuel oil?

A. I have seen it coagulate at the atmospheric temperature in experimental work.

X-Q. 154. Well, what atmospheric temperature? In New Zealand or Greenland?

A. In the city of Butte within the last ten days.

X-Q. 155. Summer or winter?

A. Within the last ten days.

X-Q. 156. You don't know what the temperature was on that day?

A. I didn't take the temperature on that particular day, no.

X-Q. 157. How much of it coagulated out?

A. A considerable amount, after having been violently agitated.

X-Q. 158. Well, don't you know any more definite than that, "considerable amount"?

A. No, I don't know the exact proportion of oil that coagulated out.

X-Q. 159. A little bit of cyanide of potassium would

be a considerable amount in a tumbler of water. I can't get any idea from you how much.

A. It amounts approximately to 20 or 25% of the total.

X-Q. 160. 20 to 25%?

A. Of the total, yes.

X-Q. 161. Did you try this experiment of the coagulating part of this Jones fuel oil by using the Jones fuel oil alone or in mixture with other oils?

A. I think it was tried both ways.

X-Q. 162. You think it was?

A. Yes.

X-Q. 163. What other oils did you mix it with?

A. The mixed oils used by the Butte & Superior at that time.

X-Q. 164. When did you do that?

A. It was done on various days.

X-Q. 165. Did you do it yourself?

A. I was present when it was done.

X-Q. 166. Did you get a sample of this froth at the Magna plant while it was overflowing?

A. No.

X-Q. 167. You took some that had been accumulated there for a period, but you don't know how long it was?

A. Yes, at the time it was taken the spitzkasten was not overflowing. How long it had not been I am not prepared to say.

X-Q. 168. How much oil was being used per ton

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on this Sunday when you were at the Butte & Superior mill?

A. The figures given by—

X-Q. 169. (Interrupting.) The figures given?

A. —by Mr. Shimmin are about 26 pounds.

X-Q. 170. 26 pounds?

A. Yes.

X-Q. 171. And how much oil was being used per ton at the Magna the day you were there?

A. The relation of new oil to new feed amounted to 21.82, as I understand.

X-Q. 172. 21.82?

A. 21.82 pounds per ton based on figures made up from our samples.

X-Q. 173. And you do not think that the oil coming back with the middlings played any part in the operation?

A. I feel absolutely sure it played no part whatever.

X-Q. 174. You feel sure it didn't?

A. Yes.

X-Q. 175. Now, do I understand you right: You say you saw the operation at the Magna plant with ~~which~~ I think you said, 21 lbs. of oil per ton, and you saw an operation at the Butte & Superior with 26 lbs. of oil per ton. You say that the operation in the first spitz at the Butte & Superior plant was the process of the patent in suit, but that the operation in the first spitz in the Magna plant with the lesser amount

of oil was not the process of the patent in suit. Was that what you said?

A. I said if the operation had stopped at that point—considering that independent and by itself—

X-Q. 176. (Interrupting.) Well, it didn't stop at that point. I am asking you the way it happened.

A. I answered concerning the whole operation as one, and considering it as stopped at that point.

X-Q. 177. Well, maybe I am hard of understanding, but I don't get the point. Both of these plants were operated with the pulp running from this first cell down through the others, weren't they?

A. They were.

X-Q. 178. And neither of them were stopped at that point, were they?

A. No.

X-Q. 179. Then why don't we cut that out? Why is it that the Butte & Superior operating with 5 pounds more oil than the Magna, is practising a process of the patent in suit and the Magna is not? I want to get your distinction.

A. I think my answer concerning the entire operation covers that point.

X-Q. 180. Well, explain it if it does; I would like to know it. I can't understand it; I can't see what that has got to do with it.

MR. WILLIAMS: I object to this mis-statement by counsel for the defendant as to the testimony of the witness, which it seems to me should not be permitted.

Ira L. Greininger.

MR. SCOTT: If you will point it out I will correct it.

THE COURT: Well, I think perhaps you place an interpretation upon his language that he did not intend; you may repeat the question if you will.

X-Q. 181. MR. SCOTT: I want your explanation of why it is that the Butte & Superior using 26 and a fraction pounds of oil per ton practises the process of the patent in suit in the first cell of the series, where all of that oil enters with the feed, and at the Magna, where they use 21 lbs., about 5 pounds less, the process in that first cell, where the oil all enters with the feed, is not the process of the patent in suit.

A. They don't get the results of the patent in suit?

X-Q. 182. Now, I will have to have you define the result again.

A. That is mineral froth.

X-Q. 183. It doesn't depend on the quantity of oil, then, whether—The determination of whether you are practising the process of the patent or not, it is the result that determines it? Is that the idea, irrespective of the amount of oil?

MR. WILLIAMS: I object to that because it seems to me that counsel for the defendant is continually infringing upon the question of construction. Here is a witness who goes on the stand and tells the appearance of certain operations and now he is asked whether the process of the patent in suit depends upon the amount of oil. I submit that there is

nothing in the testimony of this witness that warrants the putting of such a question to him.

MR. SCOTT: The witness your honor, seems to distinguish between the one and the other and I think I am entitled to find out how he does it.

THE COURT: Well, the question might be whether he is judging from his expert knowledge or the occurrence as he saw them. I don't think that is made clear. He was asked the direct question whether this, as he saw it, was substantially the process of the patent in suit in both cases, in both mills, and he answered yes.

MR. KENYON: I asked him only to compare a standard Minerals Separation process as he knew it, with what he had seen. I did not bring in the patent in suit or any question of construction of the patent in suit, just a comparison of two processes, which is a proper question to ask an expert.

THE COURT: Well, if you asked him if it was the patent process you unquestionably also asked him if it was the process of the patent in suit. There is no doubt of that because the patent process is the process of the patent in suit. Well, you will have it written out tonight, and we will see when we start in the morning.

Whereupon an adjournment was taken until tomorrow, May 10th, at 10 o'clock a. m.

Ira L. Greininger.

Thursday, May 10, 1917, 10 a. m.

MR. SCOTT: I have no further cross examination.

RE-DIRECT EXAMINATION.

BY MR. WILLIAMS:

R-Q. 184. In your testimony counsel named the fuel oil that was used at the Butte & Superior at the time you inspected the plant as Jones fuel oil, and in some of the questions and answers that name persisted. Now, what I want to know is whether your testimony in regard to that fuel oil was irrespective of whether it was Jones oil or not.

A. It was based on my memory of what I considered was testified to, but on looking up the record I find that the oil used that day was designated as fuel oil, and Jones was not attached.

R-Q. 185. When you were testifying about that oil there as a fuel oil, or as Jones fuel oil, to what oil were you referring in your testimony?

A. I was referring to a fuel oil.

R-Q. 186. Were you or were you not referring to the fuel oil that you found in those products?

A. In the mixture used at the Butte & Superior plant on the day on which the inspection was made.

R-Q. 187. And what you said about the characteristics of fuel oil, referred to that particular fuel oil?

A. To that particular fuel oil used on that particular day.

R-Q. 188. That was the fuel oil that you examined, was it?

A. It was.

R-Q. 189. Now, what has been your experience in the use of fuel oils and petroleum oils generally in the froth flotation process of Minerals Separation Limited?

A. I have never been able to make any use of them —I will say any beneficial use—as regards the extraction of minerals—of any mineral oils which I have tried. I have used them for other purposes, but I did not consider them at the time as being useful in the extraction of mineral.

R-Q. 190. For what purpose have you used them?

A. I have used stove oil for the purpose of thinning thick tar product so it would be easily fed through a small opening.

R-Q. 191. In what proportions have you used that, small or large?

A. This amounted to about 75% of the total oil used being the amount necessary to thin the tar to such an extent that it would pass through a small opening at the rate I required.

R-Q. 192. And now, as the result of your experience, how would you characterize those oils in the froth flotation process, as active or inactive?

A. In my experience, in all cases where I have tried them, they have been to my knowledge inactive, and I would so characterize them.

R-Q. 193. Where you have used them, have you used them alone, or in mixtures?

Ira L. Greininger.

A. I never have used them or attempted to use them alone—I will qualify that; I attempted to use stove oil and fuel oil alone—that is, a combination of the two, but failed to get any metallurgical results.

R-Q. 194. Whenever you used these in active oils, was there or was there not a soluble frothing agent present?

A. There was.

R-Q. 195. Now in the operations at the Butte & Superior and at the Utah Copper Company, Magna plant, that you inspected, how did the agitation compare with that of standard Minerals Separation practice?

A. Very much more violent.

R-Q. 196. In the operation as carried on in the Butte & Superior—I don't know whether you have testified to it or not, but it has appeared in the record that a material generally described as sulphate of copper was used in solution; do you remember that?

A. I do.

R-Q. 197. And you mentioned the fact that Calura was used at the Utah Copper Company?

A. I did.

R-Q. 198. Tell me whether or not these reagents are used in large proportions as compared with the use of any reagents other than sulphuric acid, we will say, in standard Minerals Separation practice?

A. The amount of Calura used at the Utah Copper plant I consider to be very large. The amount of sul-

phate of copper at the Butte & Superior has been testified to in this trial, and as to the amount of solution it was very much greater than I would consider using of anything, other than sulphuric acid.

R-Q. 199. In the report of your testimony yesterday, in answer to question 4, have you any correction to make to the evidence as reported?

A. That seems to be correct.

RE-CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 200. Mr. Greninger, have you ever used what you call the inert fuel oil together with a soluble frothing agent?

A. I have experimented with them at times.

X-Q. 201. Ever used them in a plant?

A. In a commercial plant yes.

X-Q. 202. And what was your object of combining the fuel oil with the soluble frothing agent?

A. I was attempting to improve the extraction.

X-Q. 203. What kind of an extraction did you get?

A. I got no change from what I was getting with the use of the soluble reagent.

X-Q. 204. When you used what you call the inert fuel oil, using 75 per cent of the fuel oil and 25 per cent of the tar—is that right?

A. Yes.

X-Q. 205. How much oil did you use per ton of ore?

Ira L. Greininger.

A. In the vicinity of two pounds per ton.

X-Q. 206. Of that mixture?

A. Of the mixture. I would say approximately two pounds to the ton.

X-Q. 207. On that same ore did you ever use a soluble frothing agent alone, that is by "soluble" I mean like creosote or such thing?

A. I attempted to use the tar alone, a portion of which was soluble, but I wouldn't attempt to say what, but on account of the viscous nature of the oil I was unable to feed it regularly and had to discontinue using the same.

X-Q. 208. Did you ever use any other soluble or partially soluble oil in that ore?

A. I used various wood tar oils from different timber, but they were all of the same character and nature.

X-Q. 209. How much per ton did you use on this same ore of the wood tar oils?

A. That is very hard to determine on account of as I say the difficulty in handling the thick viscous product through a spigot, which was the only way of feeding it at that plant.

X-Q. 210. Well, you know how much you used, don't you, per ton, of these wood tar oils?

A. Well, the experiments were very short and as soon as I was convinced I couldn't feed it with regularity I ceased to use them as I was working for commercial results.

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X-Q. 211. What is your judgment as to the quantity of the wood tar oils you used per ton of ore?

A. I considered at the time that I could have gotten the results with approximately the amount that I used in solution of the mineral oils, if I could have gotten the tar to the point where I could have fed it at that rate.

X-Q. 212. But you never verified that conclusion?

A. No.

X-Q. 213. By measurement?

A. Not strictly speaking.

MR. SCOTT: That will be all.

WITNESS EXCUSED.

WILLIAM NICHOLS ROSSBERG, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. What is your name, age, residence and occupation?

A. William Nichols Rossberg; I am 35 years old; I am engaged as metallurgical engineer for the Clark interests.

Q. 2. Residence?

A. Butte.

Q. 3. And your present specific employment?

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A. Superintendent of the Timber Butte mill.

Q. 4. Will you state briefly your education and experience in metallurgical lines, practical metallurgical lines?

A. I took the degree of mining engineer at Columbia University in 1904. I was first engaged on mill construction work in 1904 and have been engaged continuously ~~continually~~ since that time in mining work and milling, mill testing and metallurgical work. In 1912 I came to Butte as metallurgical engineer for the Clark interests and did the testing for the treatment of the Elm Orlu ore. In 1914 when the Timber Butte mill was started I took charge of the Timber Butte mill and have been superintendent up to the present time.

Q. 5. What work is done at the Timber Butte mill?

A. At the Timber Butte mill we are now treating the Elm Orlu zinc ore in our zinc mill and the copper tailings from the reduction works—from the old reduction works of the Colusa-Parrot Reduction plant.

Q. 6. Will you please give a description of the zinc concentrator plant at the Timber Butte mill, producing a flow sheet for that purpose?

MR. KREMER: At this time defendant wishes to interpose the same objection to this testimony, that it is incompetent, irrelevant and immaterial, not tending to prove any issue in the case; and if to prove utility it serves no purpose in the case. This is the same objection as made to the previous testimony of this character.

THE COURT: I think it probably bears on the question of extensive use. The objection will be overruled.

Defendant excepted.

MR. KREMER: This may all go in under the same objection?

THE COURT: Yes.

Q. 7. You have a flow sheet, have you, of the zinc concentrator at the Timber Butte mill?

A. Yes, sir.

MR. KENYON: At this time plaintiff's counsel offers in evidence the flow sheet produced by the witness.

Flow sheet admitted marked PLAINTIFF'S EXHIBIT No. 246.

Q. 8. Please now describe that plant from the flow sheet.

A. I might explain first that there are really only five main operations in the mill, although the flow sheet shows practically every machine in operation, The flow sheet, briefly, consists of two roughing table operations followed by flotation work. The flotation work is conducted in three stages; first the rougher operation.

Q. 9. Indicated by what numeral?

A. No. 42 on the flow sheet, near the bottom of the flow sheet. This is the rougher machine, and No. 44 is an intermediate machine, and No. 46 is our recleaner flotation machine. The intermediate and

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the re-cleaners serve to clean the rough concentrate from the rougher flotation machine.

Q. 10. Now, just comprehensively describe the whole operation, but without detail.

A. The feed is first crushed in the coarse grinding plant, and later in rolls to 10 mesh size.

Q. 11. Indicate by numerals where those crushers and rolls are as you go.

A. The first crusher is No. 4; that is a Farrell crusher; it is simply a coarse crusher. From the coarse crusher the ore is sent to a Symons crusher, which is No. 7. The ore is reduced to three-quarter inch size in the Symons breaker, and from there it is fed, over No. 8, to the secondary ore bins, or No. 9 on the flow sheet. From No. 9 the ore is conveyed to two sets of rolls, which are No. 13, and from the rolls the ore is elevated to eight impact screens, No. 15, and the undersize from the impact screens is sent to eight Wilfley roughing tables, No. 18. The Wilfley roughing tables produce a finished zinc concentrate, which is sent to our coarse concentrate bins, No. 61, at the bottom of the flow sheet. The Wilfley roughers also produce a lead-copper-iron-zinc middling, which is sent to our lead section.

Q. 12. That lead section being indicated generally by what numbers?

A. The lead section is found to the left of the flow sheet, and the elevator which supplies the lead section is No. 28. The lead section simply serves

to separate out the small proportion of lead and a little copper-iron concentrate from the zinc.

Q. 13. That is delivered where, to what bin?

A. The zinc of the lead section goes to the coarse bin, No. 61. The lead is sent to the lead bin, No. 62, and the copper-iron concentrate is sent to No. 63, and from the bins the concentrates are loaded into cars and shipped. The tailing from the Wilfley roughers is simply dewatered, or rather de-slimed, by six Akins classifiers, shown as No. 19. The overflow from the de-sliming operation or from the classifiers is sent to a thickening tank shown as No. 39, and the thickened product is sent to the rougher flotation machine. The sand portion from the classifiers is sent to tube mills for regrinding; the two tube mills are shown as Nos. 24 and 23.

Q. 14. You need not go much into detail; just follow it generally through this part of the mill.

A. Well, I was trying to follow the tailings from the Wilfley tables to the tube mills but there is some slight alteration at times, and just which of the two series of grinders those tailings are sent to, I do not remember, but the tailings from the Wilfley roughers are re-ground in tube mills, and are sent to the Wilfley and to the James roughing tables, No. 27. The James roughing tables perform the same operation as the Wilfley roughing tables; in other words, they produce a lead-iron-zinc middling, which is retreated to separate the lead and iron from the zinc.

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They also produce a finished zinc concentrate, and a tailing, which tailing is de-slimed, and the coarse portion of the tailing is reground to approximately 65 mesh, and the slime and the reground tailings are both sent to the flotation plant, through the thickener, No. 39, I believe. I should add that the reground James table tailings are sent back over the James table before reaching the flotation plant.

Q. 15. What are the mills 38 and 38-A?

A. 38 and 38-A are used for regrinding the middlings from our finisher tables, and the middlings from our flotation plant; and one of the two mills as a rule takes a portion of the Wilfley table tailings. That is a question of milling details and tonnage as to which of the mills the tailings are sent to.

Q. 16. Now, proceed from the Dorr thickener 39 into the flotation plant, as operated?

A. From Dorr thickener 39 the thickened pulp is sent to—

Q. 17. Thickened to about what dilution?

A. Anywhere from 50 per cent water up to 70 per cent water by weight. The pulp from the Dorr thickener is sent to No. 11 elevator, which is No. 40 in the description and reaches No. 41, which are simply two sludge tanks serving to take up fluctuation in the feed. From No. 41 the pulp is sent to No. 42, the flotation rougher. This is a 14 cell machine, standard Minerals Separation machine which produces a concentrate from the first eight cells and a middling

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from the last six cells. The proportion of middlings and concentrate is sometimes varied, but that is the general precedure.

Q. 18. Trace the middlings first from cells 9 to 14 inclusive?

A. The middling from cells 9 to 14 inclusive is sent to No. 49, which is an elevator and thence to two Akins classifiers No. 50. The sand portion from the classifiers or the coarse portion is shown to go to No. 38 and 38-A which are two of the tube mills already referred to.

Q. 19. For regrinding?

A. For regrinding.

Q. 20. And what becomes of the overflow of the classifiers 50?

A. The overflow of the classifiers, which is the fine material or slime, is shown to pass to No. 11 elevator or No. 40 and from there it returns to the flotation rougher for retreatment. The tailings from the flotation rougher are sent to waste. That is our total mill tailings.

Q. 21. Now, take up the concentrate from cells 1 to 8 inclusive of the rougher machine 42?

A. The concentrate from the rougher is sent to No. 43, which is an elevator taking the rougher concentrate to 44, our intermediate flotation machine. The No. 44 machine is an intermediate machine and is a six cell standard size Minerals Separation machine from which we produce concentrate on the first 5 cells, and middlings on the 6th cell and a rich tailing.

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Q. 22. Take first the tailing. Where does the tailing from the intermediate machine 44 go?

A. The tailing returns to No. 49 which is an elevator, lifting the tailing up to Akins classifier No. 50 for regrinding in the tube mills No. 38 or 38-A.

Q. 23. Take next the middlings produced in the cell 6 of machine 44?

A. The middling produced in the cell 6 of the intermediate machine simply returns back to the head of the intermediate machine in closed circuit.

Q. 24. To elevator 43?

A. To elevator 43.

Q. 25. Now, take up the course of the concentrate made in the cells 1 to 5 inclusive of machine 44.

A. This concentrate is sent to elevator 45 which elevates the concentrate to cleaner machine 46.

Q. 26. Describe that machine?

A. The cleaner machine produces a finished flotation concentrate on the first 5 cells and a middling on the 6th cell, and a rich tailing, which tailing is returned to the intermediate machine.

Q. 27. To elevator 43?

A. To elevator 43 and the middling is returned back to the head end of the cleaner or the head end of 46 through elevator 45.

Q. 28. That is the middling delivered by cell No. 6 of machine 46?

A. Yes, sir.

Q. 29. Now trace the concentrate produced by cells 1 to 5 inclusive of the cleaner machine 46?

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A. The final flotation concentrate from 46 cells 1 to 5 inclusive is sent to No. 47 which is an elevator taking the concentrate to No. 48, a de-sliming Esperanza classifier. The overflow of this classifier is the final flotation concentrate which is shown to go to No. 54 and then to 55, the latter being two Dorr thickening tanks, which thicken the final concentrate for filtering with the Kelly press No. 59. From the Kelly press the filtered concentrate is sent to the fine zinc bin No. 60, and is loaded into cars for shipment to zinc smelters.

Q. 30. What work does the Kelly press No. 59 do?

A. It simply dewaters the concentrate down to approximately ten per cent moisture.

Q. 31. And the spigot product of the Esperanza classifier No. 48, what becomes of that?

A. The sand portion of the classifier, which is the coarsest portion of the flotation zinc, is sent to No. 52, a 5 spigot hydraulic classifier, which sizes the coarse concentrate for treatment over 53, which is 7 James' sand tables. The James machine or tables, No. 53, simply serve to take out a very small portion of lead from the flotation concentrate, and a lead-copper-iron-zinc middling which is also small in quantity and is sent to the jig section through elevator 28. The No. 53 tables also take out a finished zinc which is sent to the Dorr tank No. 55, and to the Kelly press. The tailings or so-called tailings from No. 53 tables

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is very rich and is returned to 51, an Akin classifier, from which the sand portion or coarse portion passes through No. 49 and 50 to tube mills 38 and 38-A.

Q. 32. For regrinding?

A. For regrinding. The overflow of No. 51 classifier simply returns back to No. 47 elevator and after the—and over the Esperanza classifier No. 48 and over the tables; and the overflow of the classifiers finally goes into the Kelly press.

Q. 33. Are the various descriptive legends found upon exhibit flow sheet correct descriptions of the parts to which they refer?

A. Yes, sir.

Q. 34. Now, when was this zinc concentrator plant completed and put in operation at the Timber Butte mill?

A. I think the first feed was sent through the mill on June 17, 1914.

Q. 35. And the mill was fully in operation by what time?

A. Well, certainly by June 20th, 1914.

Q. 36. And has remained in operation ever since?

A. Yes, sir.

Q. 37. Will you give us from the records of the company a statement of the amounts and character of oil that has been used in the flotation process in that mill from the beginning to the present time, giving it from month to month?

A. I have the oil record here for August, 1914, up to and including March, 1917.

William Nichols Rossberg.

MR. KENYON: Plaintiff's counsel offers in evidence the record presented by the witness and it is marked plaintiff's exhibit 247.

Record admitted in evidence and marked PLAINTIFF'S EXHIBIT 247.

Q. 38. Now, will you please describe what this oil sheet shows?

A. The oil sheet shows the oil consumption in pounds per ton of original feed and in pounds per ton of flotation feed by months and an average for each year. The August, 1914, consumption is shown to be .6 of one pound per ton of flotation feed. That is the original flotation feed. The average for the year 1914 or rather for the five months—last five months for 1914 is shown to be .66 pounds per ton of original flotation feed.

Q. 39. Per ton of flotation feed?

A. Yes.

Q. 40. Not per ton of original feed—original mill feed?

A. No, sir, it would be less per ton of original mill feed.

Q. 41. That figure also is given?

A. Given as .61 pounds per ton of original mill feed.

Q. 42. The paper that you have produced also gives the acid that was used in connection with the flotation operations, does it not?

A. Yes, sir.

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Q. 43. And for the five months of the year 1914 what was the average amount of acid used?

A. It is shown to average 10.17 pounds per ton of flotation feed or 9.38 pounds per ton of original mill feed.

Q. 44. The paper also shows, for example, the average for the year 1915, does it?

A. Yes.

Q. 45. If so, please read it.

A. The average oil consumption per ton of flotation feed for the year 1915 is shown to be 1.05 lbs.

Q. 46. Of acid?

A. The acid is shown to be 9.94 lbs. per ton of flotation feed.

Q. 47. For the year 1916?

A. For the year 1916 the oil consumption is shown to be .70 lbs. per ton of flotation feed and the acid consumption is shown to be 10.19 lbs. per ton of flotation feed.

Q. 48. What does the last column of the exhibit show?

A. It shows our record of the oils used during the different months since we have operated.

Q. 49. Have you brought with you a key that will explain that record?

A. Yes.

Q. 50. THE COURT: What is the difference between the original feed and the flotation feed?

A. The difference between the gravity concentrate,

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which is taken out in the gravity portion of the mill, and the total feed.

Kenyon

Q. 51. BY MR. ~~KREMER~~: The original feed; will you explain that a little more fully, as contrasted with the flotation feed?

A. The original feed is the entire original ore received for treatement at the head end of the mill.

Q. 52. Indicated at the very top of your flow sheet?

A. Yes. The flotation feed is the portion of the original feed that reaches the flotation, and is represented by the difference between the original mill feed and the concentrate which we take out in the gravity section of the mill.

MR. KENYON: Plaintiff offers in evidence the paper last produced by the witness being the oil key, and the same is marked Plaintiff's exhibit No. 248.

Q. 53. Will you explain, now, this oil key that you have produced?

A. The oil key simply shows the oils which have been used in both our copper and zinc sections, by our own Timber Butte numbers for these oils. For instance, in August, 1914 the oil key shows that oils No. 6 and No. 140 were used; that is, Timber Butte Nos. 6 and 140. The oil key simply states briefly the type of oil and the producer.

Q. 54. For example, T. B. No. 6 is what?

A. It is a crude turpentine oil produced by the Georgia Pine & Turpentine Company.

Q. 55. What does L03 mean, occurring after

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crude turpentine opposite the number T.B. No. 6 in the oil key?

A. I suppose that is simply a trade name.

Q. 56. That that particlar oil used by you at that time bore?

A. For that particular oil; probably simply a trade designation that the producer gave it.

Q. 57. T B 140 is shown to be what?

A. T B 140 is oleic acid produced by C. T. Perry & Co., of Helena, Montana.

Q. 58. And so throughout the entire list?

A. Yes.

Q. 59. Now, as to the extent of the use of this process in that mill, can you produce some figures for us from the original records of the company?

A. I have a brief outline here showing the tonnage of zinc ore treated in the zinc section from the first of 1915 up to and including the first three months of 1917.

MR. KENYON: Plaintiff offers the paper produced by the witness in evidence, and it is marked plaintiff's exhibit No. 249.

Q. 60. Will you now explain the figures appearing on this exhibit?

A. The first column shows the date; the second column is the tonnage of original mill feed; the sheet shows a tonnage of 160,461 tons treated during the year 1915. The tons treated during the year 1916 were ~~was~~ 201,455 tons. For the first three months of 1917 we treated 41,956 tons. That ~~This~~ makes a total of 403,-

872 tons for the period shown. There was also some ore treated during a portion of the year 1914, during the time that we operated.

Q. 61. Can you state what that tonnage was?

A. That tonnage was 67,107 tons. That makes a total tonnage treated in the zinc section of 470,-980 tons.

Q. 62. Now proceed with the explanation of exhibit 249. What does the third column show?

A. The third column shows the assay of the original feed in per cent of zinc. The average for the year 1915 is shown to be 16.72% zinc. The average for 1916 was 13.38 and the average for the first three months of 1917 is shown to be 17.43. I might state that, taking the fractions, the tonnage treated during the time I detail, for 1915, 1916, and three months of 1917, is one ton greater than what I gave—that is, considering the fraction which is on the report here. The sheet also shows the tonnage of gravity concentrates produced as a zinc concentrate, as a copper-iron concentrate, and as a lead concentrate.

Q. 63. Those concentrates are separated by the water concentration part of the mill?

A. Yes.

Q. 64. And go to separate bins as shown in your flow sheet?

A. Yes.

Q. 65. Now, proceed. You need not read the details of those figures; go to the next column, flotation feed.

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A. The flotation feed is the difference between the original feed and the gravity concentrates, both as to tonnage and assay.

Q. 66. That is to say, the three gravity concentrates are added together and subtracted from the original mill feed, and the remainder is the flotation feed tonnage?

A. Yes, sir.

Q. 67. And that is how you get the figure, 148,036.83 for the year 1915, etc.?

A. Yes, sir.

Q. 68. And how is the figure "assay percentage zinc in flotation feed" obtained?

A. It is arrived at in the same manner; that is, the total zinc contained in the gravity concentrate is subtracted from the total zinc in the original mill feed, and a new assay per cent is calculated for the flotation feed.

Q. 69. Now, what is the next column?

A. The next column shows the flotation concentrate in tons and in assay per cent of zinc.

Q. 70. That is the result of the flotation operation?

A. As near as we could get at it, that is the result of flotation.

Q. 71. Now, what is the next column, total mill tailings?

A. The total mill tailing is the tailing from the rougher machine, including the zinc in the solid material, and also the small amount of zinc in solu-

tion in the tailing water. It is the total mill tailing which leaves the mill.

Q. 72. That is an actual measurement?

A. It is an actual assay, with an automatic sampler; a daily assay, and the tonnage, of course, is the difference between the original feed and the total concentrate shipped.

Q. 73. Now, what is meant by the four columns under the head "Recovery of Zinc in Original Mill Feed"?

A. The first two columns indicate the recovery of coarse and fine zinc concentrate determined in two manners; the second two columns under that heading are the recovery of zinc in all of the concentrates produced, determined in the two different manners.

Q. 74. Those two different ways that you speak of are what?

A. The first shows the recovery by weight and assay of the concentrate against the weight and assay of the original feed. The second is the weight and assay of the concentrates against the tailings assay.

Q. 75. Those ways of figuring the recovery are both proper ways of figuring recovery, are they; they check each other?

A. They are both reliable, and usually check each other, if all the assays are correct.

Q. 76. You have applied those two ways first, to the fine and coarse zinc concentrate produced, and secondly to all the concentrates produced, in columns 1, 2, 3, and 4?

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A. Yes.

Q. 77. And finally, the last two columns, headed "Estimated Recovery of Zinc in Flotation Feed" how are those figures obtained?

A. The last two columns represent the calculated flotation recovery against the flotation feed.

Q. 78. Calculated first in one way and then in the other way that you have explained?

A. Yes.

Q. 79. So that in the middle of the table under the heading "Flotation Concentrate" and the second column under the heading "Assay Per Cent Zinc," is given what we have called the grade of the flotation concentrate in zinc contents?

A. Yes.

Q. 80. And in the last two columns of the exhibit are given what we have called the recovery by flotation, expressed in zinc recovery?

A. Yes; against the flotation feed.

Q. 81. Now, will you please in a similar way, describe the copper section of the mill producing a flow sheet for that purpose if you have one?

A. I have one.

MR. KENYON: I offer in evidence the flow sheet produced by the witness and it is marked plaintiff's exhibit 250.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 250.

Q. 82. Please describe that copper section from that flow sheet?

William Nichols Rossberg.

A. The ~~upper~~ copper section is simply a flotation section within the Timber Butte mill used for that purpose. No. 1 in the flow sheet indicates the tailing pile of the Colusa-Parrot copper tailings, at the old Butte Reduction Works and No. 2 is the electric crane—the tails are simply excavated with an electric crane and are ~~is~~ loaded on to railroad cars and sent up to the mill, to No. 6, which is the storage bin from which the tailing is fed by an automatic feeder and by spouts to elevator No. 8, thence to Akins and Dorr classifiers No. 9 and 10 to two Hardinge's ball mills No. 11. The tails are ground fine enough to overflow the Akins and Dorr classifiers and are then passed to a sludge tank No. 12 serving as a storage tank for inequalities in the feed, and then from the sludge tank the pulp is sent to flotation machines 13 and 14. No. 14 is a 20 cell machine of the standard Minerals Separation type and No. 13 is a 14 cell standard Minerals Separation machine. The first 13 cells of No. 13 and the first 19 cells of No. 14 produce a finished copper concentrate which is sent to No. 16, three Dorr thickeners, which thicken the concentrate for filtering through No. 18, two Portland filters. From the concentrate bin 19 the filtered concentrate is loaded onto railroad cars No. 20, for shipment to Anaconda, to the Anaconda Smelting plant. The last cell in each of the two flotation machines produces a middling which is returned to the head of the flotation machine in closed circuit.

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Q. 83. Through elevator No. 15?

A. Through No. 15, an elevator.

Q. 84. To sludge tank 12?

A. To sludge tank 12. The tailing from the two flotation machines is sent to waste.

Q. 85. When did this copper section begin operation?

A. The copper section was started in May, 1916.

Q. 86. And has been in continuous operation ever since?

A. And has been in continuous operation ever since.

Q. 87. And what has been the total tonnage treated in this copper section?

A. The total tonnage up to and including the month of March, 1917, was 89,453 dry tons.

Q. 88. What amount of oil has been used in the operation of this copper section?

A. The average amount of oil for the year 1916 was 2.83 pounds per ton of original feed or in this case per ton of flotation feed.

Q. 89. And in the three months of 1917, the first three months?

A. The average for the first three months of 1917 was 2.28 pounds per ton.

Q. 90. And how much acid was used?

A. The average for 1916 was 9.38 pounds per ton and the average for the three months of 1917 was 5.87 pounds per ton.

Q. 91. What was the average copper content of the feed of this copper section?

A. 0.97 per cent copper.

Q. 92. What has been the assay of the tailings on an average?

A. The average tailing in 1916 was 0.266 per cent copper; the average for January, 1917, was 0.258 per cent copper. The average for February, 1917, was 0.218 and the average for March was 0.210.

Q. 93. What was the average grade of concentrate produced?

A. The average grade of concentrate for 1916 was 9.085 per cent in copper with 10.43 ounces in silver; 0.02 ounces in gold, 22.8 per cent iron; 26.5 per cent insoluble. I have the average grades for the individual months of 1917, if you wish them.

Q. 94. Please give them?

A. The concentrate produced in January averaged 8.07 per cent for the copper; 9.43 ounces for the silver; 0.0167 ounces for the gold; 22.93 per cent iron; 31.53 per cent insoluble. The February assay average was 7.95 per cent copper; 8.81 ounces for the silver; 0.0198 ounces for the gold, 20.5 per cent for the iron; 34.2 per cent for the insoluble; and the averages for March, 1917, were 8.13 per cent for the copper; 10.04 ounces for the silver; 0.02 ounces for the gold; 20.22 per cent for the iron; 32.48 per cent for insoluble.

Q. 95. And where does the ore come from that is fed to this copper section and concentrated there?

A. This ore is—the copper ore is the copper tail-

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ing at the Butte Reduction Works or works at Butte, produced by the Colusa-Parrot Company.

Q. 96. Is it a rejection of former processes practiced at the reduction works?

A. It is a reject from water-gravity concentration.

Q. 97. What is the surveyed tonnage of that dump of reject?

A. Approximately 900,000 tons.

Q. 98. And what is the copper content, average copper content of that dump?

A. The average content for the entire tailing was shown to be 1.05 per cent copper, by thorough sampling.

Q. 99. And the silver?

A. The silver as I remember it was 1.16 or 1.19, one of the two figures.

Q. 100. Ounces per ton?

A. Ounces per ton.

Q. 101. What was the value of that copper and silver in that dump estimated at the market price of 25 cents per pound for copper and considering the cost of treatment as you treat it in your copper section?

A. Well, the profit per ton right now would be approximately two dollars.

Q. 102. $1,800,000 for the entire dump?

A. Yes, sir.

Q. 103. Where, in the flotation processes that you have described, you return middlings to the head of the same machine, why do you do so? What is your purpose?

A. Simply to increase the grade of the concentrate without injuring the tailings.

Q. 104. Do you do it to save oil?

A. No, sir, we have never returned middlings for that purpose.

Q. 105. Have you ever observed that it did save oil?

A. I can't say whether it saves oil or not.

Q. 106. You have not observed that it has?

A. I haven't noticed any.

Q. 107. You have not figured on saving oil in that way?

A. No, sir.

Q. 108. Now with regard to the relation of the amount of sulphide mineral that happens to be present from time to time in the ore being treated, to the amount of oil used or required, have you ever noticed or observed any relation between them such that when the sulphide increases the amount of oil must be increased and vice versa?

A. I have never noticed any increase due to mineral content.

Q. 109. Practice has never demonstrated to you that any such rule actually holds good?

A. No, sir.

MR. KENYON: The witness is yours, Mr. Scott.

CROSS EXAMINATION

BY MR. SCOTT:

X-Q. 110. Is there any sub-aeration in any of your machines in either of these plants, air coming in from the bottom?

P. 4385, After L. 5, insert "A. I don't suppose it is quite."

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A. No, sir.

X-Q. 111. Now, is the pulp level regulated at the same relative height in the rougher cells and in the cleaner cells of the zinc section?

X-Q. 112. Intentionally is it made different in one than the other?

A. I wouldn't say for sure what the practice of the operators is right at present, but there was a time when the levels of the pulp in the cleaner cells was in question. I have not noticed the machines from that point of view recently. I don't know what they would show.

X-Q. 113. This time you speak of the level in the cleaner cells, what was it; what did you say, lower or higher?

A. Well, there was considerable doubt what the proper way to run them at the time I was noticing them was.

X-Q. 114. Did you finally decide on any way to do it, that it should be higher or lower?

A. The decision was made by the flotation foreman. I have not followed the matter to date.

X-Q. 115. You never noticed it since the foreman has decided this and began to operate the cells?

A. Noticed the depth of the froth?

X-Q. 116. Yes, and the level of the pulp in the roughers and cleaners.

A. I wouldn't say for certain, but I would say—it was my impression that the pulp is carried thicker on the cleaners.

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X-Q. 117. Than on the roughers.

A. Than on the roughers.

MR. KENYON: The witness seems to misunderstand you. He says pulp.

THE WITNESS: You mean the depth of the pulp?

X-Q. 118. MR. SCOTT: Yes, the depth of the pulp. That would be the same as saying that the pulp's level was lower in the cleaners than in the roughers, wouldn't it?

A. That is what I took your question to mean.

X-Q. 119. Where do you add acid in the zinc sections?

A. In the sludge tank, preceding the flotation work.

X-Q. 120. Can you form any idea as to about the time interval it takes for the pulp to go from the sludge tank to the flotation machine, that is whether it would be minutes or hours, on the average?

A. Well, it would be a question of minutes through the flotation machine, I presume.

X-Q. 121. Be some minutes, you think?

A. Well, I really couldn't tell. I have no definite knowledge of the time required to go through our flotation machines.

X-Q. 122. And where is the oil added?

A. The oil is added at the first cell of the rougher machine in our zinc section.

X-Q. 123. Do you use any other reagents than the zinc—any other reagents in your zinc section?

A. I might add that at times we have added oil in the middle of the machine, but our practice right at the present time is to add the oil at the first cell.

X-Q. 124. And do you use any salt or mineral reagents in the zinc section?

A. No, we do not.

X-Q. 125. Can you state whether the pulp is more —or is as dense when it reaches the flotation machine as it is in the sludge tank?

A. I haven't made any—I have never conducted any experiments along that line at all.

MR. SCOTT: That will be all.

(WITNESS EXCUSED.)

The witness notes in reading the above that the word "pulp" in his answer to X-Q. 116 should be "froth."

CHARLES H. FULTON, Called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION:

BY MR. WILLIAMS:

Q. 1. Please state your name, age, residence and occupation?

A. Charles H. Fulton; 43; professor of metallurgy in the Case School of Applied Science at Cleveland, Ohio; residence, Cleveland, Ohio.

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Q. 2. Please state your experience in matters relating to mining and metallurgy?

A. I am a graduate of the Columbia School of Mines, Columbia University, New York City, in 1897. My first experience in practice was as superintendent of a gold mine near Redcliff, Colorado. I held that position for two years. After that I was instructor in metallurgy at the University of Wyoming for two years. After that I was professor of metallurgy at the South Dakota State School of Mines, Rapid City, South Dakota, for five years. After that I was president of the South Dakota State School of Mines until 1911. From 1911 until the present time I have been professor of metallurgy in the Case School of Applied Science. During 1906-8, while employed at the South Dakota State School of Mines I also held the position of consulting engineer and manager for the Standard Smelting Company at Rapid City. During my residence in the West I have examined a large number of mining properties in South Dakota, Colorado and Idaho, and have done other professional metallurgical work in a consulting capacity. In connection with my educational work every summer I have had occasion to visit metallurgical centers with classes of students and in this manner I have seen a very large number of mills and metallurgical works in the United States and have become intimately acquainted with the practice of this art. I have seen flotation carried on at the Inspiration mines, the Miami mine, and the Old Dominion mine in Arizona and at the

Anaconda plant in Montana, and at the Magna mill of the Utah Copper Company in Utah.

Q. 3. Please explain the methods employed in the practical work of concentrating ore up to March, 1905.

A. I shall take the liberty of referring to my notes in this connection. The final recovery of metals from their ores is accomplished in most instances by a smelting operation. This is particularly true, of copper, lead and zinc, and to a considerable extent for gold and silver, although the two latter metals, especially gold, are also recovered by the so-called wet process, in which chemical solutions are employed. This is done to some extent for ores of zinc; copper in a minor degree is recovered by wet methods. The great bulk of all the metals except gold is recovered by smelting operations. In order to smelt economically it is necessary that the furnace charge be high in metal content. Thus, for instance, in zinc smelting it is necessary that the ore charge into the retort of the distilling furnace contain not less than about 40 per cent of zinc.

In smelting copper concentrates in reverberatory furnaces, the same general condition holds true, except that a lower copper content, say from 8% upward, according to conditions, is required.

Ores with this high metallic content are relatively uncommon and the great bulk of ores is of low metal content, in fact at the present time, great quantities of copper ore as low as 1.5 to 2 per cent copper are worked at good profit. Before the metal in these low

grade ores can be recovered economically by smelting it is necessary to *concentrate* the metallic minerals into a small bulk of high grade material. This is done by removing a portion and in some cases nearly all of the worthless gangue, the operation being known as concentration. The gangue of the ore is the non-metallic part of the ore, or the earthy minerals such as common quartz, the lime carbonate and such barren rock as may be mixed with the ore.

COMMON PROCESS OF CONCENTRATION. The common process of concentration consists in crushing the ores and submitting the crushed product to the action of water currents in different forms of apparatus whereby the heavier metallic minerals are separated from the lighter gangue chiefly by virtue of the difference in specific gravity between the two kinds of minerals. In order to effect the separation it is necessary to so crush the ore that the metallic minerals be freed from the enclosing gangue after the manner that the kernel of a nut is freed from the enclosing shell. It is evident that if the valuable metallic mineral occurs in relatively large pieces or crystals, the crushing may be coarse, but if the valuable mineral occurs finely disseminated in small particles the crushing must be fine in order to free the valuable mineral from the gangue.

It is well known that many of the metallic minerals, particularly the sulphides of lead, copper, silver, etc., are much more brittle and friable than the gangue so that in the process of crushing the amount of fine par-

ticles of these minerals produced is relatively much greater than that of the fine gangue particles. These very fine particles of metallic mineral and gangue are known ~~as shown~~ as slimes. The above facts would not have any particular significance except for the phenomenon that the fine slime particles do not obey the laws by means of which large and moderate sized particles are recovered in the ordinary process of concentration, and hence in a large measure are lost.

In ~~concentration~~ connection with concentration practice, slime is solid matter in such a fine state of subdivision that the viscosity of the medium in which it is suspended is able to retard the velocity of its settlement by imparting to it a virtual specific gravity less than normal. Applied particularly to the metallic minerals in a fine state of subdivision this ~~seems~~ means that the small mineral particles act as if they had a specific gravity approximately that of the moderate sized gangue particles. Since in concentration it is the difference in specific gravity which causes the separation of valuable mineral from gangue, anything which causes the virtual specific gravity of the valuable mineral to approach that of the gangue will cause the valuable mineral to join the gangue and thus be lost.

It is apparent from the above that from the standpoint of the ordinary concentration process the production of slimes is to be avoided as much as possible, for, while a wealth of apparatus exists for the recovery of slime, such as slime concentrating tables, canvas tables and buddles, none of these make high recovery

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and they simply represent the best there is available for the purpose.

However, in endeavoring to avoid the production of slimes, another serious difficulty arises which leads to conditions as bad, if not worse than the production of slimes. With ores that have the valuable mineral disseminated in comparatively fine particles throughout the mass of gangue, fine crushing is essential in order to free the particles of valuable mineral. If this be not done, and particles of valuable mineral remain attached to particles of gangue, the specific gravity of the piece is such that it will probably not join the concentrate but will pass out with the gangue and thus be lost. Or if it is recovered, it carries with it the objectionable gangue.

It is therefore evident that in the ordinary process of concentration a balance must be struck between fine crushing, which will produce a large amount of slime, and such a degree of crushing as will produce but little slime but will permit valuable mineral to remain locked up in the gangue. If methods were at hand for a substantially complete recovery of the valuable mineral in the form of slime, fine crushing would lead to very high extraction of valuable mineral from the ore, but all known methods and devices of the ordinary concentration system when applied commercially fall far short of complete recovery. The ore is therefore crushed to such a degree in each individual case as will yield the economic recovery under the existing circumstances.

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While the foregoing statements represent facts that are a matter of common knowledge to metallurgical and mining engineers it is desirable to confirm them by quotations from the writings of the foremost authority of the world on ore-dressing, Professor R. H. Richards.

ORE DRESSING, Vol 1, page 303.

Q. 4. This book that you have produced, when was it published?

A. It is the edition of 1903.

Q. 5. Have you any knowledge personally of the fact that this book was published in 1903?

A. I bought this particular volume in 1903; the date is marked in the book.

Q. 6. With your signature?

A. Yes.

MR. WILLIAMS: I think it is admitted that this is a publication of 1903.

MR. KREMER: It is certainly not disputed, Mr. Williams.

Q. 7. And volume 2, what is the date of the publication?

A. 1905.

Q. 8. And did you purchase that book at the time of its publication?

A. Yes, I did. That is not my own copy, however.

Q. 9. Have you these quotations in your notes so that you do not need to refer to the book?

A. I have.

"Extent of crushing desired. At first sight it would

seem desirable to crush rock down to a size which shall be equal to the size of the smallest particle of valuable mineral. This would ensure perfect separation. In practice, however, there are several objections to this plan. It causes all the coarser particles of valuable mineral and gangue which are unlocked at larger sizes, to be crushed unnecessarily, thereby using an extra amount of power and causing an increase in the amount of slimes which are difficult to separate and which cause loss. This trouble of slimes is aggravated by the fact that in a majority of cases the valuable mineral is softer than the gangue and hence slimes more. For all these reasons it is an advantage in most cases, except where the mineral is all finely disseminated to crush first to a much coarser size than the finest particle, then to separate out as much clean mineral and clean gangue as possible, and to recrush the residue. This process can be repeated indefinitely, but in practice the added cost and the mechanical difficulties limit the number of repetitions to one or two. The ideal thing in crushing would be to have every grain of mineral remain intact and be entirely cleaned from all adhering particles of gangue. This is impossible to obtain in practice and there will always be some particles of mineral which are entirely surrounded by gangue. Such particles are known as attached or included grains and help to make up the middling product in the subsequent separation."

Vol II, page 1120. "The slime question is one point on which the author believes there is much room for

P. 4394, L. 26, after " which " insert " have particles of gangue attached to them or which "

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improvement. In discussing this question there are two ideas to be considered: First, the means of preventing slimes as far as possible; second, the arrangement for treating such as are unavoidably made. For the prevention of slimes the use of graded crushing, graded sizing and graded jigging is probably the greatest help. This has been previously discussed in several places in the book and needs no further explanation here. For the crushing, rolls are to be preferred, in general, to stamps and most other fine pulverizers. Only on rare occasions, as for the very fine crushing of middlings, is the use of stamps justifiable. On a soft galena-blende ore at Ramsbeck, in Westphalia, the grizzley has only 30 mm. spaces, instead of the usual 50 or 60 mm. This sends finer ore to the cobbing and avoids much of the fines which would be made if the stuff between 30 and 60 mm. were crushed directly by machine. While graded sizing will save losses by slimes, yet, when carried to extremes, the advantage desired may be lost owing to the large amount of attrition which results from the rounding of the grains in passing the ore over the large number of screens and concentrators necessary when close sizing is used. This attrition causes losses in slimes. Attrition may occur in other ways, and to keep it down all unnecessary handling of the ore should be avoided and the necessary handling should be done by proper machinery. For example, the use of centrifugal pumps, especially of the radial discharge type, is to be condemned for elevating soft ores like galena; bucket ele-

vators would be better. There is one loss from attrition that cannot well be prevented, and that is from the wear that occurs in the bed of a jig. Slime losses may be reduced by taking care that where the coarse is separated from the fine it be thoroughly done. By exercising this care not only will losses of slimes be saved, but the washing of the coarser material is better and easier done. Examples of losses of slime from its being mixed with coarse are on jigs which are fed imperfectly with classified materials, slime table and vanners fed with extremely fine pulp mixed with the coarse. On the slime tables the very fine concentrates are lost on the sand side of the table, while on the vanner they pass down with the tailings. The remedy for both of these losses is to separate out the extremely fine and treat it by itself. Greasy flotation is a source of slime loss which may be partly prevented by making sure that the ore is thoroughly wetted at the start and that during the course of its treatment it does not have an opporunity to partly dry again. The actual treatment of fine slimes is by no means an easy problem. Some mills, for example, settle the whole overflow of their classifiers and send these settlings directly to the smelter without any further treatment. Extremely fine slimes should not ordinarily be treated on a vanner, but rather on a slime table or a canvas table, because the shaking motion does not allow the fine particles to settle out of the rapid upper layer of the water."

Vol. I, page 4. "Greasiness. This is the term used

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to express the tendency of minerals to float on the surface of water as if they were greasy. It is caused by the aversion of the surface of the particle to become wetted. The particle may carry an air bubble down with it, which later floats it to the surface, or its dry surface may prevent its sinking at all, the particle floating at the base of a little dimple or depression on the surface of the water. This causes much trouble in ore-dressing. All minerals exhibit the tendency, but with some species it is very marked; for instance, in native copper, native gold, cassiterite, sphalerite, graphite, and some of the silver minerals. This property may be regarded rather as a difficulty to be overcome than as a help, for the reason that it cannot be depended upon—at one moment a given grain will float, at another it will sink. An approach towards a useful effect may be gained by forcing large quantities of air in fine bubbles to the bottom of the sand in a water tank. The floating scum when caught by gentle dipping transverse gates often gives a higher assay than any product in the mill."

Vol. II, p. 890. "Greasy Flotation. When particles refuse to become wetted they may float in a little dimple in the surface of the water, or if immersed they may retain attached to them air bubbles which float them up later. This principle, however, is so unreliable and difficult to control that it is usually considered more an injury than a benefit."

Vol. II, page 1119. "Tendency and Future. The tendency is distinctly toward graded crushing, graded

sizing and graded washing. The jigging of larger sizes is being experimented upon until certain mills are jigging 1 to ~~1/5~~ 1½ inch stuff with good results in the prevention of slimes and in diminishing the cost of crushing. Although the invention of tables of the Wilfley type has given some strength to the plan advocated by Hallet and Bartlett of breaking the whole lot of ore to a small size before abstracting any portion of the values, yet this scheme seems destined to be of limited application only, since the former scheme has too great advantages over it; the lump ore is not slimed with its resultant losses, and the power for crushing is saved. The future progress to be made in ore dressing will probably be more in the development and perfection of existing processes and machines than in the introduction of new processes. Not that new processes do not appear—for they are brought out constantly—but their disappearance is usually as sudden as their appearance. The modern wet concentration method seems eminently suited to most of the problems, but it is weak or altogether fails when there is only a slight difference in specific gravity between the mineral and the gangue, or when water is lacking, or when dealing with very fine slimes. Under these conditions it becomes necessary to make use of some one of the several processes given in Chapter XVIII of the book. For separation in such cases a broad theoretical basis is lacking."

The chapter 18 referred to includes "operations of occasional application, such as magnetic concentration,

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roasting for magnetism, pneumatic concentration," and the following line of processes:

"1. Separation by centrifugal force.

"2. Roasting by porosity.

"3. Heating for decrepitation.

"4. Disintegration followed by screening.

"5. Disintegration followed by settling or elutriation.

"6. Weathering.

"7. Adhesion."

Under adhesion, the Elmore process of bulk oil flotation is described on page 831 of Vol II.

"Theoretically the proper application of principle should have a perfect separation with a given ore. Practice, however, seldom, if ever, obtains such results, and the chief reasons for imperfect work are given in the order of their importance below.

(a) Fine slimes.

(b) Included grains, meaning grains still attached to or surrounded by gangue.

(c) Flattish grains.

(d) Compact grains, which has an effect if the concentrator is run too fast.

(e) Oxidized, or weathered grains."

Quotation from Vol. II, page 892.

"Considering mills 1 to 43 inclusive, we have the valuable mineral contained in the form of sulphide, associated with gangue. We have, after crushing, the valuable mineral existing, as

(a) Compact grains,

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(b) Flattish grains,
(c) Included grains,
(d) Fine slimes."

Whereupon an adjournment was taken until 2 p. m.

2 p.m. May 10, 1917.

The compact grains (a) are easily separated unless the machines are run too fast. The flattish grains (b) are difficult to separate owing to their slowness in settling. The included grains (c) prevent a perfect separation since they oblige us to send gangue into the heads (Concentrates) and values into the tailings, or else make a middling product requiring retreatment. This middling product will include also some of the flattish grains. The fine slimes (d) are saved with difficulty because they settle so slowly and are so easily carried forward by water current that the commercial limit is reached before the last of the values is saved."

From the foregoing explanations and citations it is evident that the common process of concentration is far from perfect and that there is much room for improvement. Its chief imperfections lie in its inability to deal satisfactorily with slimes, or the very ~~way~~ fine particles produced during crushing, and hence in most instances the operations of the process are conducted in such a manner as to prevent as far as possible the production of slimes. The avoidance of slimes, however, carries its penalty with it for if slimes are avoided part of the ore is insufficiently crushed and the so-

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called "included grains," previously defined, appear and cause difficulty, for they are apt to be lost by joining the gangue, and if they are separated out as a middle product, they must be recrushed to a fine state, thus giving rise to a certain amount of slimes. In exceptional ores that contain the valuable mineral in comparatively large grains the slime question may not be a very serious one, and recoveries of between 80 and 90% of the valuable mineral are possible, but if as usual the ores contain the valuable mineral disseminated throughout the mass in fine and very fine grains it is necessary to crush all the ore to a fine state at the very beginning of the concentration operation with the consequent production of a large amount of slime.

If average disseminated copper ore be taken as the basis for a calculation, the ore will contain 1.82% copper. This is equivalent to 36.42 pounds of copper per ton of ore. The average recovery or yield by the ordinary concentration process on this type of ore may be taken as about 70% (maximum), equal to 25.5 pounds of copper per ton of ore. The loss therefore is 10.9 lbs. of copper per ton. The above recovery is the best obtainable by very careful work aided by extensive installations of slime saving devices, such as thickeners, tables and buddles. The recovery by smelting may be assumed to average 92%, so that an ore containing 36.42 lbs. of copper will yield 23.46 pounds of copper bullion. This at 14 cents is equal to $3.28. The total cost of production of the copper in a ton of ore must therefore be less than this. In some instances

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the cost approaches closely to this figure so that the margin is small indeed. If a marked drop occurs in the price of copper, the margin disappears and may turn to a loss.

If a comparatively simple process were found to replace the elaborate and imperfect slime concentration system now commonly in use, and which would increase the extraction or yield to 90% of the copper in the ore and above, and at no greater cost, it is perfectly evident that considering the tremendous interests involved, such a discovery would be considered epoch making in the mining industry.

Further, if this process were applicable to lead and zinc ores, in the same manner as for copper ores, it would take on even greater importance, and be entitled to rank as one of the great inventions of the metallurgical art.

The bothersome slimes problem would disappear, as slimes could be treated without difficulty. Fine crushing could be resorted to so as to liberate practically all mineral particles from gangue, and the loss from included grains be avoided. The whole concentration system could be much simplified, for in place of the complicated crushing in stages, graded sizing and graded washing, the ore could be at once reduced to fines by two or three crushings, and the fine product treated, the sand by water concentration, the slime by the simple new process in question, or the whole product be treated by the new process.

I have now described the art as it existed in the mills

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and the expectations of the art as expressed in its literature on and about March, 1905, and where I have used the term concentration, or the term "common process of concentration," I have referred to the then known water concentration processes that I have described.

Q. 10. Now, today, where flotation is not in use is or is not this process of water concentration the process of the art?

A. Yes, it is.

Q. 11. Were you one of the parties representing the plaintiff who went to the Magna plant of the Utah Copper Company during this trial and observed the operations being conducted at that plant?

A. I was.

Q. 12. I show you plaintiff's exhibit 245, flow sheet, Magna mill, Utah Copper Company, visit of April 22nd, and ask you whether or not that correctly represents the operations as they proceeded on that day?

A. It does.

Q. 13. Will you from your memory describe generally the operations that were conducted there and the observations made by you?

A. In the Magna plant there were two sets of Janney Flotation machines. The machines were treating the concentrate from Frue vanners. The concentrate from the vanners were collected and sent to a hydraulic classifier, the overflow from which, with a certain amount of underflow, passed to the Dorr thick-

ener and a number of settling cones. The thickened product from the settling cones and the Dorr thickener passed to a sludge box, and from the sludge box were fed to a Janney agitator known as emulsifiers, and from the emulsifiers passed to double spitzkasten cells, 17 in one machine and 16 in the other. The oil was fed below the sludge tanks in a separate box. I watched particularly the machine known as number 1 which had 17 double spitzkasten.

Q. 14. What did you observe in the spitzkasten of this machine?

A. I observed froth being discharged from the spitzkasten in cell Nos. 2, 3, 4, 5, and 6, which was led away as finished concentrate. The froth discharged from other cells, that is from below six to 17, was returned to the sludge box as a middling. I observed the oil feed at the head of the emulsifiers and saw the tailings discharged from the machine. I further saw the addition of the reagent which is termed calura, both at the head of the machine with the oil and at a number of cells from the top towards the bottom.

Q. 15. Is this feed of the calura indicated in the flow sheet, plaintiff's exhibit 245?

A. Yes, that is correct.

Q. 16. What was the condition of things in the spitzkasten number 1 as observed by you?

A. Spitzkasten number 1 was not discharging material regularly. It was not provided with a discharge paddle. There was room for it there, but it was not

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in operation so that spitzkasten number 1 was we might say practically lying dormant and was not an active cell for the discharge of froth.

Q. 17. Does what you saw apply to both of the spitzkasten of cell number 1?

A. Well, if I stand at the bottom of the machine and look toward the head, the right spitzkasten number 1 was very inactive. There would be a little flow of material from its surface, perhaps five or ten minutes every hour. The left one, however, would discharge somewhat more frequently, although by no means regularly.

Q. 18. This matter of the discharge of the spitzkasten is that a matter of adjustment of levels?

A. Yes, there is a valve on each spitzkasten, the amount of opening or closing of which determines the overflow over the lip of the spitzkasten.

Q. 19. Was a specimen taken from spitzkasten number 1?

A. It was.

Q. 20. What have you to say as to that specimen? What was it a specimen of?

A. The specimen was that of a float—of the float on top of the spitzkasten. It was very oily in appearance and when taken on a glass disc or watch glass—a large one—and wetted down with water it seemed to divide itself into three compounds; first, a sort of floating oily emulsion carrying traces of mineral and, second, oil-air bubbles, like frog spawns, call it, carrying very little mineral and easily separated from the rest

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of the material by panning, and third, the ordinary agitation froth, but in small amounts.

Q. 21. Now, what did you observe and what was done as to the second spitzkasten?

A. The second spitzkasten was discharging the agitation froth regularly. It had a more oily appearance than froth that I have seen at other mills.

Q. 22. And the third spitzkasten?

A. The third was very similar to the second, perhaps with somewhat less oil apparent.

Q. 23. And the fourth?

A. The fourth, like the third. The fourth spitzkasten, to my recollection, discharged more froth than the second or third.

Q. 24. Now, as to the fifth and sixth?

A. Like the fourth, except that the froth became somewhat less oily, quite noticeably so, on the fifth and sixth.

Q. 25. And the sixth, as you have described it, was the last one which discharged a finished concentrate?

A. The last one to discharge a finished concentrate.

Q. 26. Now, we come to No. 7; what did you observe on the surface of that spitzkasten?

A. No. 7 on the surface had a whitish gray froth in relatively small amounts, and small floating areas of oily material, a sort of oily float. The amount of froth on No 7 was very decidedly less than on Nos. 5 and 6. The overflow—the water level was carried much higher on No. 7 than it was on 5 and 6 and the froth more readily discharged.

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Q. 27. And now you might follow those spitzkasten down the line, making any further comments or grouping them together as you think best.

A. The amount of froth diminished as we progress from No. 7 down to No. 17. The amount of oily float also diminished very appreciably, so that on the lower ones of the machine this was not apparent. The only overflow there was the light-colored froth.

Q. 28. Now, were your observations and the taking of specimens confined to the spitzkasten at one side of these double machines?

A. They were; to the right side when facing the head of the machine.

Q. 29. Was that by agreement with the representatives of the defendant?

A. It was.

Q. 30. The matter of the determination of the amounts of oil and of the assays as to the amount of metal in the floats was not attended to by you, was it?

A. It was not.

Q. 31. What was done with the specimens that were taken?

A. We took all the specimens and transported them by a car, ourselves being present, to Salt Lake City, and there they were placed on the railroad train and delivered to the laboratory in Butte.

Q. 32. The laboratory of the plaintiff?

A. Yes.

Q. 33. At the time of the inspection by our representatives of the Butte & Superior plant, Sunday,

April 29th, were you or were you not present in Butte?

A. I was not present.

Q. 34. You had gone back home for a time?

A. Yes.

CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 35. Did you understand the process by which this froth was made which you saw in the plant of the Magna plant at the Utah Copper Company?

A. I believe I did, yes.

X-Q. 36. What was your purpose in going there to inspect the operations?

A. We went to the Magna plant to see in what manner the plant was operated and under what conditions it was operated.

X-Q. 37. Did you consider the operations that you saw at Magna as conducted according to the same process as the operations at the Butte & Superior mill?

A. I did not see the Butte & Superior mill.

X-Q. 38. Oh, you did not see the Butte & Superior mill; I beg your pardon. You have seen operations conducted at other mills, have you not?

A. I have.

X-Q. 39. By an agitation froth process?

A. I have.

X-Q. 40. At what other mills?

A. I have seen the process conducted at the Inspiration mill in Arizona, at the Miami mill in Arizona, at

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the Old Dominion mill in Arizona, and at the Anaconda mill at Anaconda.

X-Q. 41. Do you regard that operation that you saw carried on at Magna plant as exemplifying the same process that was carried on at Anaconda and Old Dominion?

A. I do.

X-Q. 42. The product you regard as being the same product that is formed at Anaconda and at Inspiration?

A. I do, yes.

X-Q. 43. I will say Old Dominion, because I think both of those have the mechanical agitation, haven't they?

A. Yes.

X-Q. 44. Do you know how much oil was used at Magna the day you were there?

A. Yes, I was present at the taking of the oil sample. I did not weigh up the oil, or make any calculations, but I was told that it was 21.8 lbs. per ton of feed.

X-Q. 45. Well, we will assume for the present that that is correct; I think it will be proved before we get through. How much oil were they using at Old Dominion when you were there?

A. I don't remember.

X-Q. 46. Have you any recollection whatever?

A. Well, it was a small amount; under 1%.

X-Q. 47. What was it at Anaconda, do you remember?

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A. I do not.

X-Q. 48. Do you know whether it was over or under 1%?

A. It was under 1%.

X-Q. 49. And you say that the same process was being carried on at Magna as was being carried on at Anaconda and Old Dominion?

A. Yes.

X-Q. 50. Now, I would like to read you a passage from your testimony given in the suit of Minerals Separation Limited against the Miami Copper Company. You testified in that suit, did you?

A. I did.

X-Q. 51. It will be from Volume I, page 428, beginning at X-Question 54: "X-Q. 54. Is it your opinion as an expert in this matter that the formation of this froth, referred to in the passage you quoted, is dependent upon the reduction of the quantity of the oil to a fraction of 1 percent of the ore? A. Absolutely, yes, sir. X-Q. 55. Is it your opinion as an expert that this froth will never result when the quantity of oil is more than 1 per cent of the ore? A. Not this froth, no, sir. X-Q. 56. Well, what other froth will result? A. A small scum, or perhaps a comparatively copious mixture of oil and air bubbles and gangue and metalliferous particles may rise to the surface if air and oil be mixed, but it bears not the slightest resemblance to the froth that is produced when the amount of oil is reduced to that which is specified in the patent in suit. X-Q. 57. You think you would be able to distinguish,

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do you, between the froth produced with less than 1 per cent of oil and one produced with over 1 per cent? A. I believe I could; yes, sir. X-Q. 58. You are not sure of it? A. Well, if the amount of oil is, say, .98 per cent in one case and 1.01 in the next case, I doubt whether I could. X-Q. 59. Well, we will give you a little more latitude. Suppose it was 2% in one case, and nine-tenths of 1 per cent in the other. Could you then distinguish? A. Well, nine-tenths is over the limit I believe." The last answer that I read was "Well, nine-tenths is over the limit, I believe." By that expression you mean that nine-tenths of 1 per cent of oil was an amount too great for the carrying out of the process of patent No. 835120?

A. Not necessarily, no.

X-Q. 52. What was your meaning?

A. Why, it means that with that amount—that with over that amount you could not produce the typical froth so that the froth would be apparent and be that froth only.

X-Q. 53. I asked you there in the last quoted question and answer if you could distinguish between a froth formed with 2% and one with nine-tenths of 1 per cent and your answer is: "Well, nine-tenths is over the limit, I believe. Now, I don't understand your explanation. Nine-tenths is over what limit?

A. Well, we were speaking of the froth, not of the process, as I understand you?

X-Q. 54. Yes.

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A. Now, with that amount it would produce a float or froth which is distinguished from the froth of the process—distinguishable; you can tell the difference?

X-Q. 55. With nine-tenths of 1 per cent it would?

A. Well, somewhere near that, yes.

X-Q. 56. Let me state that over; I don't quite understand you. I will read again another passage from page 429, beginning with X-Question No. 64.

"X-Q. 64. Yes. And just what is the difference between these scums that are produced with 5 or 10 per cent., and those the patentees have discovered could only be produced with 1 per cent? A. The patentees' froth contains practically all of the mineral, and this other froth contained very little. X-Q. 65. You mean that the patentees, forming a froth with less than 1 per cent of oil, got practically 100 per cent of the valuable mineral in there? A. Not 100 per cent, but they got a very substantial mineral recovery. X-Q. 66. Yes. And you never have a substantial recovery then, with over 1 per cent of oil? Is that the thought? * * * X-Q. 67. Now, I think my last question related to what is the difference between these froths formed with less than 1 percent of oil, after the fashion of this patent in suit, 835,120, and those other floating masses that you have referred to as consisting of oil and air bubbles and mineral, and having a larger quantity of oil. What is the principal difference? What is the difference in phenomena, if your experience as an expert enables you to give us the distinction? A. Well, the froth which is produced by the very small quantity of oil, perhaps

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other matter, consists practically entirely of air and attached mineral. That is, the mineral is attached to the air bubbles. There may be a very large amount of air present; that is, the air may be large in volume, and the mineral may be relatively small or the mineral may be relatively large; that is, coating the bubbles very closely. That is a function of the amount of mineral which is present in the ore. On the other hand the froths or scums, or whatever they may be termed, magmas, which are produced when this greater quantity of oil is present, consist for the most part of the oil with some of the mineral that has been entangled and some of the gangue, and perhaps some air bubbles which have been forced into that mass.

"The difference, from a practical standpoint, is that the froth which is produced with this small amount of oil or other material contains the larger part of the mineral, while the other froth contains very little."

Is that correctly quoted?

A. Yes, it is.

X-Q. 57. Now, beginning at cross-question 73 on page 432: "Now, where does this change come, become the comparatively poor as you think, froth, with large amounts of oil and the froth which you think is much richer and has a small quantity of oil? Is there no sharp line of demarcation, or does it come all of a sudden, if your experience enables you to answer?

"A. Why, I think that the line of division is an extremely sharp one; that if the oil is present, say in 2 or 3 per cent of the ore, that phenomena happen which

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rather tend to go over into the bulk oil flotation; that is, the oil itself has a tendency to entrap the mineral, to raise it to the surface. Of course, the effect with the amount of oil you have mentioned there is very slight, but if the oil be reduced to the quantity specified in the patent mentioned here, the physical phenomena change entirely from what I have seen." Is that correctly quoted?

A. Yes.

X-Q. 58. Is that still your opinion?

A. It is.

X-Q. 59. You have seen these photographs that were introduced in evidence of froth or were you away at that time?

A. I was away at that time.

X-Q. 60. I would like to begin reading with question 85 from the Miami record, page 434, question 85. "If you have explained it as well as you can, we will go on to something else. You have stated that this oil in these small quantities, something to the effect that it does not act as an oil any longer, and that you can do it with something else. What does that mean?

"A. That means that we can get that same froth, which contains valuable mineral, or a larger part of it, without what is technically known as oil, and with certain other substances like alcohol.

"X-Q. 86. Well, do they both do the same thing?

"A. Essentially, yes; they produce the same results.

"X-Q. 87. In the same way?

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"A. In the same way, I believe, yes.

"X-Q. 88. They do not involve any intricate differences whatever?

"A. I do not believe so." That was your testimony wasn't it, in the Miami case?

A. Yes.

X-Q. 61. I would like to read one question and answer, question 17, page 589, the answer to question 17. "Why, in the cyaniding of slimes pulp by agitation, the agitation must necessarily be very thorough and violent. At the same time that the agitation is carried on, it is essential that air be introduced into the pulp for the purpose of furnishing oxygen to dissolve gold in connection with cyanide, and also to destroy certain chemical salts which are formed and which would use up cyanide. The agitation of ore pulp in cyanidation is a prolonged one, as a usual thing, all the way from twelve to twenty-four hours, depending upon the ready solubility of the silver or gold mineral which is present." That was your testimony in the Miami case?

MR. WILLIAMS: I object. I think that the matter has gone quite beyond the limits. The mere fact that Prof. Fulton has heretofore testified on something which is wholly irrelevant to his direct testimony would not seem to me to warrant the question.

THE COURT: Yes, I think the objection is well founded. Sustained.

X-Q. 62. MR. SCOTT: In your visit to the Magna plant did you make any distinction between what was going on in say the first cell of the machine and that

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which was going on in the second or third or the fourth or any other one?

A. Yes, I make a very decided difference. The first cell was not an active frothing cell, but in my opinion was a cell to remove oil and oil float, which it very successfully did.

X-Q. 63. Well, was what went on in that first cell the same process that you saw at Anaconda, and Old Dominion?

A. It was not.

X-Q. 64. It was not?

A. No.

X-Q. 65. Where did that process first appear?

A. In the second cell, the second being the first active cell.

X-Q. 66. You say it was not the same process merely because the froth was not overflowing at the time you saw it?

A. Why, the first cell could really not be considered as a frothing cell. You might just as well have had say a tank interposed between the sludge box and the first frothing cell as to have had that cell there.

X-Q. 67. Wasn't there any froth on it?

A. Why, there was some float rising to the surface but very little.

X-Q. 68. Wasn't there agitation going on?

A. Yes, there was some agitation, yes.

X-Q. 69. Just as much as in any cell, wasn't there?

A. There was no froth removed.

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X-Q. 70. There was just as much agitation in that cell as there was in any of them, wasn't there?

A. Just as much agitation there as in the emulsifier for instance.

X-Q. 71. Or in any other cell provided with spitzkasten boxes?

A. Yes.

X-Q. 72. And there was a circulation of pulp going on from the agitation box to the spitzkasten and back wasn't there?

A. I suppose there was some.

X-Q. 73. Just as much as in any of these, wasn't there?

A. There was no float being taken off.

X-Q. 74. I understand that.

A. So that the valves must have been perhaps closed down with very small degree of openings so the passing through would be very small.

X-Q. 75. What valves do you mean must have been closed?

A. Well, there is a connection between the agitator and the spitz. Now, I am not very thoroughly familiar with the Janney machine. I don't know the construction of the valve, but there must be some opening there.

X-Q. 75½. Well, don't you know that there is no valve on the circulating opening that permits the pulp to circulate from the agitating box into the spitz and back?

A. I am not familiar with the details of the Janney machine.

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X-Q. 76. You said the valve must have been closed. But now you must have asumed that there was a valve there didn't you?

A. When I say "valve" I have reference to some connection between the agitator and the spitz, which I suppose was controlled by some arrangement.

X-Q. 77. Well, you really don't know anything about that, do you?

A. I know very little about the Janney machine.

X-Q. 78. Well, now, we have the agitation equal to the other cells as you state, and we have the froth. Now, that froth must have risen from agitation, mustn't it?

A. I didn't say we had froth.

X-Q. 79. Lets' call it whatever you want to?

A. Some little float.

X-Q. 80. Did it carry any mineral?

A. Why, very little; mostly oil.

MR. SCOTT: You asked for the report of the proceedings of that day and I would like to offer it now.

MR. WILLIAMS: I should like to examine it care fully before you offer it.

MR. SCOTT: This was asked for by you and you said you would accept it in this form and I have produced it for you and I offer it in evidenc.e

MR. WILLIAMS: I certainly am not going to accept any document of that kind until I have examined it. I didn't bind myself to absolutely accept anything that was handed to me.

MR. SCOTT: We will wait for you to examine it so we can proceed with the witness.

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MR. WILLIAMS: I will accept it in evidence subject to possible criticisms and the requirement of further proof. I cannot accept it absolutely.

MR. SCOTT: It is noted that the report consists of typewritten sheets with a blue print flow sheet attached.

Document admitted in evidence and marked DEFENDANT'S EXHIBIT 251.

X-Q. 81. Did you observe the floating mineral upon the surface of this spitz box of the first cell?

A. I observed the float there, yes.

X-Q. 82. And was the sample that was taken by your party a representative sample?

A. Yes, it was.

X-Q. 83. And the assay return of that sample shows it to have contained 18.98 per cent sulphide of copper, 19.4 per cent iron, and 27.3 per cent insoluble. Do you regard that as a useful or useless operation producing a concentrate of that grade?

A. That would depend what relation it bears to the regulation concentrate made in the plant.

X-Q. 84. Are you familiar with the regulation grade made there?

A. I am not.

X-Q. 85. And you have no independent idea of whether that concentrate made from a heading containing 7.095 sulphide of copper, 8.3 iron and 69 per cent of insoluble would be a useful operation and a good one metallurgically?

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A. I should say it was very poor concentrate to obtaind from such high heads.

X-Q. 86. I find from the report of the operation at Magna the day of your visit that part of the concentrate from spitz box number 10, carried 183.95 pounds of oil per ton, that is per ton of concentrate. Now, would you regard a concentrate carrying that amount of oil as being produced by the same process that you have seen at Anaconda and at Old Dominion?

A. It might be, yes.

X-Q. 87. You think that you could observe that amount of oil in that concentrate don't you, by the sense of touch?

A. Yes, easily.

X-Q. 88. Probably could see it with the eye, couldn't you?

A. Yes.

X-Q. 89. There would be no trouble about knowing it was there?

A. No.

X-Q. 90. You think the luster and color of the mineral would be covered up and concealed by that amount of oil?

A. Well, the product or concentrate there is something quite different from froth. It is a float, an oily float, which occasionally rose to the surface and is entirely distinct from the real product of the process, which is the froth. It is a by-product, something incidental, which arises, probably due to the excess oil,

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but it is not the froth in any sense of the word. It is something entirely distinct.

X-Q. 91. Did you state just at the end of your direct examination that wherever oil flotation was not in use water concentrating was the method? I am not sure I am stating it right, but I think that was the way you put it?

A. Well, I don't believe I said just that. I said the ordinary process of concentration was wet concentration. That is known as the common process of concentration.

X-Q. 92. What is used where oil flotation is not used for concentrating?

A. Of course water concentration is used widely. Some mills still use water concentration and some mills use water concentration in conjunction with flotation; some mill use flotation only. Then you might have a mill using what we term magnetic concentration, on certain ores.

X-Q. 93. And when you say "flotation" do you mean to confine it to oil flotation?

A. I confine my meaning to the agitation froth process.

X-Q. 94. With oil or an equivalent substance?

A. Some equivalent substance.

X-Q. 95. Do you know of any flotation process that does not employ oil?

A. Not in use at the present time, no, sir.

X-Q. 96. You do not know of its being in use, you say?

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A. You mean of oil only?

X-Q. 97. No, I mean of flotation without any oil.

A. I am not personally familiar with any. I haven't seen any.

X-Q. 98. You don't know that there are none?

A. There may be some, I don't know.

X-Q. 99. Now, Prof. Fulton, if that first cell at the Magna plant had been overflowing at the time you saw it—and I think some of the other witnesses said they did see it overflowing at times during the day—would you then have regarded the operation being carried out in that cell as a carrying out of the same process that you saw at Anaconda and Old Dominion?

A. Why, in respect to the small amount of real agitation froth that it discharged, I would say so, but not in connection of acting as an oil overflow.

X-Q. 100. You mean that this float was not homogeneous, that some of it was what you call agitation froth such as seen at the Anaconda or Old Dominion and the rest of it was something else?

A. Yes.

X-Q. 101. Then, under some conditions I take it to be your opinion that the float produced by agitation, an ore pulp containing oil, may consist of partly one kind of a float and partly of another kind of a float?

A. Just consists of the real agitation froth which carries most of the mineral, and then the excess oil may go in there as an emulsion, as it was very evidently on the cell I saw at the Magna. You could separate

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this product very easily on a glass placque, that would show very clearly.

X-Q. 102. Then the effect of this excess oil in this instance you are speaking of was not to prevent the formation of the agitation froth such as you saw at Anaconda and Old Dominion, but the effect is merely for the oil to exist alongside of and with the true agitation froth?

A. Well, from my observation of the first cell it seems to break it down and act perhaps detrimentally to that first cell, and this concentrate was very much poorer than it was in the second cell, to the eye.

RE-DIRECT EXAMINATION BY MR. WILLIAMS:

R-Q. 103. Prof. Fulton, have you any explanation of the agitation froth process?

A. No, I have not.

R-Q. 104. Have your assistants in the Case School of Applied Science made any investigation as to this question of explaining the process?

A. One of my assistants, Mr. Thomas M. Baines made rather extensive investigations in the theory of ore flotation. It is a very attractive subject and one that naturally interests the scientific mind. He being an electrical engineer rather leaned to the electrical theory of flotation, and from what I have seen of his experiment and conversations with him—

MR. KREMER: We object to this as hearsay and and incompetent.

THE COURT: Yes, objection sustained.

MR. WILLIAMS: Exception.

R-Q. 105. Do you accept the adsorption theory as an explanation of flotation?

A. I do not. I do not consider it as a proven theory or as a proven fact. I do not even believe it is a theory. I think it is at present merely an hypothesis.

R-Q. 106. Do you accept the electric theory as an explanation of flotation?

A. I do not. I think the electric theory is a mere hypothesis at the present time.

R-Q. 107. Do you know of any really scientific investigation that has been made on the subject of flotation?

A. Not to my knowledge.

MR. WILLIAMS: That is all.

(WITNESS EXCUSED.)

GEORGE A. CHAPMAN, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q. 1. Mr. Chapman, were you one of the party representing the plaintiff who visited the Magna mill of the Utah Copper Company on April 22nd, during this trial?

A. I was.

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Q. 2. And at that plant observed the operations being carried on.

A. I did.

Q. 3. Is this drawing, plaintiff's exhibit 245, a correct flow sheet of the operations as they were conducted?

A. It is.

Q. 4. Please describe what you saw and what your observations were at the time of that visit without attempting to give the full details of the flow sheet, which appear, but giving your observation?

A. I saw the stream entering a classifier said to contain the vanner concentrate from the upper part of the mill being suitably thickened and delivered to the sludge tank, and passing from the sludge tank to this stream was added oil and a solution known as calura. The whole pulp then passed through in one section of the flotation plant through two emulsifiers and 17 double spitzkastens Janney machines. In the other flotation machine there were three emulsifiers and 16 Janney double spitzkasten, double flotation machines. After a conference between Prof. Fulton, Mr. Janney and myself, it was decided to examine the machine with the two emulsifiers only, and also to take samples from one side of the machine for convenience and to save time. This product after passing through the emulsifier and entering the Janney machine—these machines were carrying out the Janney operation of the agitation froth process. High grade concentrates were being recovered from boxes,

2, 3, 4, 5, and 6. From 7 on to 17 a middling product was being recovered with heavier overflow.

THE WITNESS: On the first spitz box practically no ore concentration was being shown. I should consider that first spitz box merely for oil recovery. Any mineral that was caught in this oily float I considered to be mechanically caught there, possibly with slight traces of the agitation froth process, but its one purpose was not really for mineral concentration, but for oil concentration.

The additions of calura were very large, and the first calura addition after the pulp left the sludge tank was by means of a three-quarter inch pipe which was running full stream. Other calura additions were made at various parts of the machine and entered into No. 2 agitator, No. 3, No. 4, No. 5, No. 6, No. 7, No. 8, No. 10, and No. 14. The addition of this calura produced an alkaline condition of the circuit toward the end of the machine, which was more marked as you get toward the end box.

The tailing discharge was in the usual manner, from a spigot from the 17th cell, and the concentrates were delivered to suitable collectors.

Now, the overflow from the first box on the side of the machine that we were examining was very intermittent; I judge that it overflowed perhaps ten minutes in every hour. This intermittent overflow interested me so much that I made several visits to the other side of the machine, and I noticed that of the five visits that I made, it was overflowing on four

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occasions; and indeed it would be quite easy, and it would be a great temptation to remove that oily float continuously in ordinary operations.

Q. 5. Did you do anything by way of special examination or separation of the constituents of the float in spitzkasten No. 1?

A. I did.

Q. 6. What did you do, and what did you observe?

A. I placed that oily float on a plaque, and noticed that it could be very easily divided into three products; first, a collection of oil globules, badly broken up with air; second, a sunken oily slime; third, oil globules which sank through the water and could be very easily separated from the settled slime. That separation was even more marked on boxes 2 and 3, where we had more solids to make a comparison. There again we could separate this oily float and could very easily wash off the oil globules which were relatively lighter than the sunken concentrate, and the sunken concentrate had the appearance of the ordinary concentrate that could be vanned from the result of the agitation froth process.

In looking around, it was a great surprise to me that our friends at this plant had not taken advantage of this fact that this oil was so free, and obviously oil costing money, that they had not taken advantage of this simple means of separation to recover a large proportion of their oil.

Q. 7. What was the character of the float as it appeared to the eye on the top of spitzkasten No. 2?

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A. Spitzkasten No. 2 produced a typical agitation froth, except that it had an oily appearance, and showed the presence of the golden transparent oil bubbles carrying no mineral.

Q. 8. Now, as to spitzkasten No. 3?

A. Practically the same thing, except I should say the oil was slightly reduced, the free oil.

Q. 9. Spitzkasten No. 4?

A. Spitzkasten No. 4 we were getting to a point when we began to get the typical-looking froth, with still a slight trace of excess of oil.

Q. 10. Spitzkasten No. 5?

A. Well, we could say right down to No. 6 there was a gradual diminution of the oil and a brightening up of the mineral, showing that there was less oil in the later boxes.

Q. 11. And these spitzkasten, 1 to 6, were the spitzkasten that were delivering the finished product?

A. They were delivering the finished product.

Q. 12. Now, spitzkasten No. 7, what did you observe on the surface of that spitzkasten?

A. Spitzkasten No. 7 had a higher water level with a quick removal of the froth, not only assisted by the quantity of water going over, but it was mechanically assisted over by a revolving paddle. It is true that all the boxes had this, except I think it was either 10 or 11, where there was no mechanical paddle, due to the fact that the motor set to drive the shaft for those mechanical froth removers was set at that box. The froth covering over was much lighter in color, and

up to, say, box 12, there were streaks of oil float which could be very easily recognized; particularly on box 10. These streaks were quite apparent and passed over the lip of the spitz boxes in quite separate products. This was so interesting that I asked Mr. Janney, and consulted with Prof. Fulton, that we should examine these streaks, and we took several samples of these, but of course in getting this oil float on top of the ordinary agitation froth, it was difficult to get a sample of this actual float without obtaining a large portion of the light-colored froth. This condition went on to a more or less extent right along in the machine to about the 13th or 14th box, I should say, when these streaks more or less disappeared.

Q. 13. You speak of them as streaks; what proportion of the surface of the spitzkasten was covered by these streaks?

A. On box No. 10 that I particularly examined, I should say 20%.

Q. 14. Did you get a specimen of this streak?

A. I did.

Q. 15. In what box?

A. Box No. 10.

MR. WILLIAMS: I will say that Defendant's Exhibit No. 251 will be accepted in evidence with the same force and effect as if the assayers had appeared and testified.

Q. 16. Now, in defendant's exhibit 251, there appears about a page entitled "Magna Plant Sample No. 8 B, machine No. 1, Spitz No. 10, dark-colored

oily concentrate; assay analysis and oily analysis." Is the material that is described as dark, oily concentrate the same as that you have referred to?

A. It is; it is the sample as collected.

Q. 17. And what does this oil analysis show?

A. It shows that of a total weight of the sample of 28.953 grams, the oil contained was 2.663 grams.

Q. 18. Now, I suppose you compared that with the light-colored froth from Spitz No. 10, which appears on the next page?

A. The total weight of the sample was 19.345 grams, and this contained a total weight of 0.657 grams of oil.

Q. 19. Have you examined the assays and oil analyses set forth in Defendant's Exhibit No. 251?

A. I have casually glanced at them.

Q. 20. Have you looked them through sufficiently to determine what they show as to the various products?

A. I would prefer to have a little more time on that.

Q. 21. Did you also visit the mill of the defendant on April 29th during this trial as a representative of the plaintiff?

A. I did.

Q. 22. Please generally describe what you saw in the way of operations, without giving any further details of the flow sheet than you think necessary to make your explanation clear, having in mind the fact that the flow sheet has already been explained in evidence.

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A. The products from the upper part of the mill were made by the ordinary process of water concentration. After being suitably reground and thickened, these products were delivered to a flotation plant. This plant consisted roughly of seven rougher machines and three cleaners, the three cleaners acting in series, not in parallel. There is return products, namely from the fourth, fifth, sixth, and seventh spitzkasten and the various rougher machines, together with the middling product of the first cleaner, the second cleaner and the third cleaner, were returned to the head of the plant and mixed with the crude feed. The first three spitz boxes of the rougher machines were delivered to the first recleaner. The appearance of these first three boxes, particularly the first two, showed the presence of a considerably oily gangue, which gangue could be easily separated from the main portion of the concentrates, by a simple vanning of the products. The middlings overflowed from the rougher machines carried considerable water, or rather circuit liquor, in which was suspended a considerable amount of fine clay gangue. The reagents that were being used were sulphuric acid and copper sulphate solution, which I understand was obtained from Anaconda, and the mixture of oil was said to contain 70% fuel oil, 18% pine oil and 12% kerosene. Mr. Shimmin's later report gives more exact figures for these as follows: Standard Yaryan pine, 24.03%; fuel oil, 64.47%; commercial kerosene, 11.23%. This oil before being added to the flotation circuit was warmed, I judge to be-

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tween 40 and 60° C. There were occasions when the oil temperature dropped lower than 40°, but for the major part of the time it was above 40°. The oil addition was being made, at the time of our arrival, at the discharge end of one of the tube mills, but it was perfectly evident by examining the discharge of that same tube mill, that the oil reagent had been added to the feed end of the tube mill, and had been changed over just before our arrival. The first part of the day was spent with Mr. Shimmin and Mr. Hackwood in arranging for various samples to be taken, and check samples for both sides. The sampling proper ~~connected~~ commenced at one o'clock and continued until 5. These samples were taken and gave entire satisfaction to both parties, and should represent fairly well the operations that were being carried on on that afternoon. Three of these samples, the return middlings from the various cleaners, were grab samples, and can only be considered as specimens, but in my opinion they represent the normal running operation of these streams. The only reason why time samples were not taken of the whole of the run was because the streams were very hard to get at and very difficult to sample. I and Mr. Hackwood personally took these samples. One feature of the tailings that is worthy of note: I was fully expecting to find some incipient granules, owing to the fact of the proportion of oil specks that looked like granules, but on close examination proved to be solid oils.

(Recess).

P. 4432, L. 28, after "oil" insert "that was being used, and at first I discovered dark"

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Q. 23. What was the condition of the feed to the flotation plant as regards new feed at the time of your inspection of the Butte & Superior—the material in that feed?

A. The new feed was in a pulp of modified water and I examined the upper part of the mill very thoroughly, but could find no additions of oils there so I assumed that the presence of soluble agent was due to return water from either the concentrator thickener or the tailings dam.

Q. 24. What was the dry material composed of—or I presume we can call it the ore that was fed to the flotation plant?

A. It was zinc ore.

Q. 25. Had it any characteristics?

A. Well, the chief characteristic was clearly shown after it had been ground up. It was very evident that there was a large proportion of clay gangue slimes in the pulp, a condition which was rather a surprise to me after knowing the samples of Butte & Superior ore that we had been treating for some time in previous litigation.

Q. 26. What was the result, if you know, of this presence as clay gangue slime in such large quantities in the pulp?

A. Why, this clay gangue slime~~s~~ ~~have~~ has the effect of absorbing the oils and rendering these oils inactive for the functions of the oil flotation process.

Q. 27. And did you observe whether that happened

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at what occurred in the Butte & Superior plant when you were there?

A. It was perfectly obvious by the condition of the rougher concentrate and finished concentrate.

Q. 28. Is this matter of oil absorption by the gangue a phenomenon that you are familiar with in flotation operations?

A. Perfectly.

Q. 29. When the oil is absorbed by gangue is it of any use in the process of froth formation?

A. It is absolutely lost to the process.

Q. 30. Did you make any observation as to the amount of return middlings as compared with normal agitation froth process operation?

A. The return of these middlings was much larger than I have ever seen before for two reasons. The first reason was that the middlings overflowed from the rougher machines carried considerable circulating liquor with them; and the other reason having three recleaners. There were three middling streams being returned to the original flotation feed.

Q. 31. I would like you to look at the flow sheet, defendant's exhibit 222, and tell me where the tailings from the three recleaners were returned to?

A. To the feed of No. 1 cleaner.

Q. 32. Then what you have said as to the returns from all of the cleaners going to the head of the plant, if that is what you said is not quite correct?

A. Not quite correct. I am mistaken.

Q. 33. The material returned from No. 3 cleaner to

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No. 1 cleaner would go through No. 1 cleaner, No. 2 cleaner and No. 3 cleaner, is that right?

A. The tails from No. 2 cleaner are marked on this sheet "tails to tail race".

Q. 34. Now, is it or is it not true that the material which was returned from No. 3 cleaner to No. 1 cleaner, also the material going to No. 2 cleaner—

A. The tailings from No. 1 cleaner are returned to No. 3, 36 inches elevator, and are returned to the flotation feed.

Q. 35. And what material goes from No. 1 cleaner to No. 2 cleaner?

A. The cleaner concentrate.

Q. 36. What operation did you observe in that part of the plant which has been described as the air cells?

A. Well, I saw there a series of Callow pneumatic cells. They were operating on the tailings from the rougher machines. A low grade concentrate which should be considered as a middling was being produced in these machines and returned to the circuit. My time was pretty well occupied in superintending sampling arrangements and general observations of the plant and I had no opportunity to trace out that product to the upper part of the mill, but I assume that that will be correctly shown on the flow sheet we have just been looking at.

Q. 37. What in your opinion was the process being carried out in the Butte & Superior mill at the time of your visit that you have described ?

A. It was undoubtedly the process of the agitation froth process.

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Q. 38. What factors in your opinion contributed to making that process the agitation froth process, in view of the amount of oil that was being fed into the plant?

A. By adding suitable oily reagents to the pulp of finely crushed ore and water and agitating to produce a separation and froth, is what I understand to be the agitation froth process. The admission of these oils may be sometimes of two characters, those that are actually active in the process, and perform the necessary functions, and those that are inactive in the process. I have on many occasions used inactive oils, particularly those like fuel oil, kerosene and stove oil to produce a condition of froth in the spitz box that will maintain a steady condition of overflow. The addition of these reagents in small quantities is extremely useful for ~~the~~ this purpose and considerably eases up the operating work.

Q. 39. Then, as I understand you, such oils as fuel oil and kerosene and stove oil are not active oils in the agitation froth process?

A. Not to my knowledge.

Q. 40. And your knowledge is based upon what?

A. My practical experience since 1905 in the agitation froth process.

Q. 41. Now you spoke of little particles or granules of oil which you saw in some part of the process. What have you to say as to the operation that was indicated by the presence of these little particles of oil?

A. Well, this particular oil passing out with the

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tailing to my mind was a demonstration that it was an inactive oil and escaped by that means. There is possibly the same inactive oil in the various froths that were produced in the plant but I couldn't distinguish them in the froth.

Q. 42. You say that this was oil? In what condition was it, liquid?

A. No, it was in the form of little nodules of grease.

Q. 43. And was there any manipulation that in your view would tend to the production of these little nodules of grease?

A. Why, the addition to the plant of an inactive oil. The oil, of course, was delivered to the flotation section warm and sent to the circuit which I should judge to have been on that day between ten and twelve degrees Centigrade and that would certainly cause this particular grease to become solidified although it was a freely running oil when it entered the plant.

Q. 44. About the proportion of the clay gangue in the middlings. Did you see any indication of these?

A. The middling was practically all of this clay gangue.

Q. 45. Have you ever in your experience in the agitation froth process taken any account of the oil returning in the circulating feed in connection with the amount of new oil that you feed to the machine?

A. I never have.

Q. 46. What have you to say about its effect in enriching the feed in mineral contact, as to whether

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that is something that you take into account in ordinary agitation froth operation?

A. Yes, in the return of such middlings from the retreatment of concentrates it has always been my aim, and I think it has been generally practiced to allow this return to be about or nearly above the assay of the original feed. If this amount is exceeded you lose the value of flotation feed and thus you are more likely to produce a richer tailing.

Q. 47. That is to say return of mineral in the middling enriches the feed and as a general rule enriching the feed means richer tailings?

A. Means richer tailings.

Q. 48. I would like you to repeat your description of the middlings which were returned in this plant at the Butte & Superior. What did they consist of?

A. The middlings of the plant at the Butte & Superior?

Q. 49. Yes, the middlings returned; what did they consist of?

A. The middlings returned to the feed elevator was the spitzkasten overflow of 4, 5, 6 and 7 boxes.

Q. 50. And did you observe what material overflowed there?

A. Quite light colored froth with quite a large proportion of fine clay gangue suspended in the pulp.

Q. 51. And then that middling return was composed of what?

A. Low grade mineral, some mechanically caught coarse gangue and this fine clay gangue that was returned in the flotation pulp.

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Q. 52. I think you said something about the middling consisting entirely of clay gangue. Just what did you mean?

A. Well, the presence of that clay gangue was so striking—perhaps I still have the impression on my mind—but it certainly contained besides the clay gangue some low grade concentrate and as I stated before some mechanically associated coarse gangue.

Q. 53. What is the table that I now show you?

A. This table refers to the visit to the Butte & Superior mill on April 29th of this year.

Q. 54. What are the determinations on this table?

A. The determinations are the assays of the various final products and the amount of oil contained therein.

Q. 55. And these assays and oil determinations were made by whom?

A. Dr. McIlhaney.

MR. WILLIAMS: The sheet referred to is offered in evidence as Plaintiff's Exhibit No. 252, and it is stipulated that that shall be received in evidence with the same force and effect as if the assayer were called and testified.

MR. KREMER: Of course with the right to show any inaccuracy if any should appear in any of these assays as referring to the check samples. I don't think there will be any, but we have not had an opportunity to examine this yet. We will compare it now.

Q. 56. Have you any correction to make to this document as it is here—I note that you have a memorandum on your copy, state what that is.

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A. Under the title "Product" there are two products; "concentrate sands" and "tailing sands." These should be called "concentrate sharps" and "tailing sharps."

Q. 57. How would you define a sharp as distinguished from a sand?

A. Why, a sand indicates a gangue product, whereas the term "sharp" would include both concentrate and gangue.

Q. 58. Now, can you give a brief description of this table with the result; take the heading "Dry Waste, Total in Four Hours' Run." That was based on what kind of samples?

A. These are the actual samples taken at the mill.

Q. 59. Automatic time samples?

A. The concentrates and tailings were automatic time samples. The concentrates were deslimed—well, they were mixed with water and allowed to settle one minute, and deslimed and separated into the two products in the proportion which is given in that table. The concentrate sharps— These figures are applied to the total tonnage for the four hours we were there, and sampling, and we have taken the figures given in Mr. Shimmin's report. Now the concentrates are divided, assuming the production of 60.16 tons of concentrate in that four hours, there were 31.37 tons of sharps and 28.79 tons of slimes.

Q. 60. And the figure 60.16 which is here obtained exactly agrees, does it not, with that other figure~~s~~ marked "From B. & S.?"

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A. From B. & S. We have taken that figure for that calculation.

Q. 61. Now, is the percentage of heads divided in the same manner?

A. That is divided in the same manner. The tails are divided—there was a total of 203.03 tons, and the tails were divided into 11.4 tons of sharps and 9.97 tons of slimes. The total percentage of these tailings is 77.2% of crude ore treated. This 77.2% was divided into 42.3% of shares and 34.9% of slimes. These next products were assayed separately as follows: Concentrate sharps assayed 46.9% of zinc; concentrate slimes assayed 41.8% of zinc; a composite assay of the two was 44.5% of zinc.

Q. 62. And the Butte & Superior figure is 45.2?

A. 45.2. That is within reasonable limits of assaying and sampling errors.

Q. 63. Continue.

A. Of the tailings, the sharps assayed 1.49% of zinc and the slimes 1.91% of zinc and a composite assay of these products was 1.68, against 1.57% of zinc from the Butte & Superior assays, which is within reasonable limits. The calculated assay from those various products of heads was 11.44% of zinc against 11.53% of zinc, Butte & Superior assays, which is again within reasonable limits. Now, the recovery of the zinc in the concentrates on these figures is shown in 88.7% zinc against the figures of the Butte & Superior Company of 89.5, which is within reasonable limits. Now, this recovery, of this 88.7 recovery,

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48.8% recovery was in the sharp portion of the concentrate and 39.9 in the slime portion. Of the 11.3% lost in the tailings, 5.5% was lost in the sharps and 5.8% in the fines. Now these products, the oil determinations were made on them with the following results: The concentrate sharps carried 22.8 lbs. of oil per ton; the concentrate slimes carried 93.4 lbs. per ton. A composite figure derived from these two is 56.6 lbs. per ton of the total concentrates, against 62.6 lbs. per ton Butte & Superior figures. The oil determinations of the tailings showed 14. lbs. per ton of oil which could be divided into the sharp tailings of 0.296% of oil and in the tailing slimes, 30.6% of oil. The next column, the percentage of total oil to feed is as follows: 50% of the total oil used was recovered on the concentrate; 10.5% of which was on the sharp portion of the concentrate and 39.5% on the slime portion. 41.7% of the total oil was determined to be on the tailings, of which 0.5% was on the sharp portion and 41.3 on theslime portion. Now, the total oil recovered has been divided into two portions; on the sharp portion of the concentrate there was 10.6 per ton.

Q. 64. Of what kind of oils?

A. Volatile oil.

Q. 65. Do you know, as a matter of fact, that that was a natural division in the work of oil determination?

A. Well, I am not qualified really to go into the chemistry of oil, and I accept these figures as given by

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Dr. McIlhaney, and if there is any explanation to make, I think he can make it. 10.6 lbs. per ton of volatile oils on the concentrate sharps; 42.9 per ton on the concentrate slimes; the composite figure for these two is equivalent to 29.1 lbs. of volatile oil on the total concentrates recovered. Tailing sharps contained 0.172 lbs. per ton of volatile oil and 16.2 lbs. of volatile oil on the slimes. The composite figure on the total figure is 4.7 lbs. per ton of volatile oil. The percentage of the division of these volatile oils recovered in the various products is as follows: In the concentrate sharps it is 12.29%; concentrate slimes, 52.34%, making a total on the concentrates of 64.63%. For the tailing sharps, 0.71%; for the tailings slimes, 34.66%, making a total for the tailings of 35.37%. Of the non-volatile oils that ~~was~~ were contained by the concentrate sharps, 12.2 lbs. per ton; concentrate slimes 44.2 lbs. per ton, and total concentrate, 27.5 lbs. per ton. On the tailing sharps, 1.124 lbs. per ton.

Q. 66. 0.124 I have it.

A. My copy gives it 1.124.

MR. WILLIAMS: We will put that in as 1.124 at present, and we will check it up.

A. The tailing slimes, 20.4 lbs. per ton. The total tailings, 9.3 lbs. per ton. The percentage of the non-volatile oils represented by these various products is as follows: Concentrate sharps, 10.8%; concentrate slime, 35.89%; total, 46.69%. The tailing sharps, 0.39%. Tailing slimes, 52.92%. Total tailings 53.31%.

Q. 67. Now, as to the lower figures of these col-

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umns, you did not give them all; the amounts of oil, did they check up?

A. No, there is a loss. Of the total oil, 91.7% is shown to be on these various products, and that checks very closely with the Butte & Superior figure of 93.4%.

Q. 68. And the difference between that and 100 is the loss in the determinations?

A. The loss in the determintions, yes.

Q. 69. Do you know of any particular circumstance that would contribute to the fact that the loss was 8.3% in one instance and 6.6% in the other instance; if you do not know you may just answer that you don't.

A. Well, it is possible that the determinations made by Dr. McIlhiney include both volatile and non-volatile oils, while those of the Butte & Superior are of the total oils, and that was totaling the amount of the determinations, and it might possibly account for that slight difference.

Q. 70. You think the loss of the oil in solution in the water of the pulp, would that contribute to the failure to account for the total amount of oil in the product?

A. If I understood Dr. McIlhaney correctly, he took all the water with the product.

Q. 71. So that any soluble frothing agent would have appeared in the calculations?

A. Yes.

THE COURT: Are you asking the witness to account for the difference between the two assays?

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MR. WILLIAMS: No, the difference from 100.

THE COURT: He answered as to the discrepancy between the two assays, as I understood it.

THE WITNESS: I did in my first answer, yes, sir.

MR. WILLIAMS: Q. Is it or is it not to be expected that in an operation of this kind with considerable quantities of oil divided up into separate products, that the oil determinations will account ~~of~~ for all of the oil?

A. Well, it is practically impossible.

Q. 72. Now, was there any characteristic of this process as carried on by the Butte & Superior in regard to agitation that was different from the normal agitation froth operations that you are familiar with?

A. I should say the agitation was greatly increased over the standard Mineral Separation practice.

Q. 73. THE COURT: What effect would that have, or has it any that you know of?

A. Why, it would have the effect of beating these inactive oils against air bubbles, and possibly be carried to the surface on air bubbles. We used to have the same effect with the Cattermole process, where some of the granules by agitation were broken and would become attached to one single air bubble, and would be carried practically to the surface, and then the bubble would break and the broken granules would fall in the form of a flock, and I think it is quite possible that this very violent agitation would cause a partial—well, a very fine subdivision of these inac-

tive oils, and allow them to be caught with air bubbles and taken over with the flowing froth.

Q. 74. MR. WILLIAMS: Returning now to the Utah Copper Company inspection, have you a table of the results of analysis and deter—and examination of the samples obtained?

A. Yes, sir.

MR. WILLIAMS: I offer in evidence this table. as plaintiff's exhibit No. 253, with the same stipulation as the last and same exception.

MR. KREMER: I don't think there will be any occasion for that; it may be admitted.

Exhibit No. 253 admitted.

Q. 75. Now, what does this table show?

A. That the assay of the flotation feed was 7.4% copper. The concentrates recovered were 26.3% copper and the tailings rejected were 0.2% copper. The indicated recovery, by the well known formula, is 97.9% recovery. The oil on the concentrates and tailings was estimated as follows: The total oil on the concentrate was 2.81%; total oil on the tailings was 0.199%.

Q. 76. And this is divided up between the volatile and non-volatile?

A. Yes—The volatile oil on the concentrate—

Q. 77. You need not give those figures. Now as to the recovery of oil fed, 1.06%, or 21.15 lbs. per ton, what did you find there?

A. That 73.1% was associated with the concen-

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trates and 13.6 was associated with the tailings, making a total of 86.7%, meaning a loss of 13.3%; but I should not like to say that that is due to any error in the assaying, for it must be understood that we had only four hours to sample this particular run, and our samples partook more of the nature of specimens rather than time samples, so it is quite possible that that error or most of it can be accounted for in that way.

Q. 78. Now, you have here the skimmings of the first spitzkasten, with a total oil of 26.24%. Is that the float that you described as appearing in the first spitzkasten?

A. It is.

Q. 79. And the next two, concentrate from second spitzkasten, with a total oil figure of 4.87%, that is the amount of oil that was found in that second spitzkasten?

A. It is.

Q. 80. Now, have you examined the determinations made in behalf of the Utah Copper Company, exhibit No. 251?

A. I have.

Q. 81. Having before you all of these determinations, and having seen the plant in operation, I wish you would say what process was being carried on at the Utah Copper Company on the occasion of your visit?

A. The process employed at the time of our visit was undoubtedly that of the agitation froth process.

The incident of that oil removal at the first spitz box, not being one of ore concentration, I would exclude that one box; but the rest of the plant was undoubtedly the agitation froth process.

Q. 82. Did you observe whether or not the oil fed to the plant was fed in a heated condition?

A. It was, at a temperature of 62° C.

Q. 83. And was the pulp heated or not?

A. The pulp was normal temperature.

Q. 84. About what was it on that day?

A. Ten to fifteen degrees Centigrade. There may have been just a little heat or raise in temperature by reason of the fact that the pulp was kept in suspension in the sludge tank by means of a small jet of steam—or perhaps that was compressed air; I will have to look at my notes. I will withdraw that last statement: it was compressed air.

Q. 85. It was suspended by compressed air and not steam?

A. Compressed air, that is all.

Q. 86. But there was no heating in the plant except to the oil?

A. The oil and the calura.

Q. 87. Now, you have testified, and other witnesses have testified repeatedly about the standard machines of Minerals Separation Limited. I show you the drawings in the Hyde Record, entitled "Plaintiff's Exhibit, King John's Court, Standard Plant," appearing on pages 1027, 1030 and 1031, and I might note that the evidence shows that this plant was in

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operation in the laboratory in King John's Court in the latter part of the year 1910. Now, I ask you how that flotation apparatus or machine appears to you to compare with what you have referred and the other witnesses have referred to as the Minerals Separation standard plant?

A. These drawings practically represent the standard machine of today, with the exception that the pipe C on the sheet has been replaced by a curved pipe, to do away with the right angle turn, which causes unnecessary wear and chokes up at times. The baffle F, has been reversed.

Q. 88. That is, instead of pointing up it now points down?

A. It points down.

Q. 89. Those are all the changes that have been made in the last seven years?

A. That is all. Those machines also appear to be belt driven, but most of the modern machines are gear driven.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 90. Mr. Chapman, if the first cell at the Magna plant had been overflowing and discharging float regularly, would that have altered your answer in which you stated you considered that the process that you saw at Magna was the agitation froth process?

A. If that float had been removed continuously,

that box, which is merely acting as an oil remover and not as a cencentrator at all—

X-Q. 91. Well, would you consider that the process carried out there was that of the agitation froth process?

A. You mean the machine as a whole?

X-Q. 92. Yes.

A. Certainly.

X-Q. 93. And if you make any distinction, what would you say about that first box?

A. That first box was merely there to prepare the pulp for the final successful treatment by the agitation froth process.

X-Q. 94. How about the first box in the Butte & Superior installation. Considering it separately as you have considered the one at Utah separately, was that box being used for the agitation froth process?

A. Yes, it was, but in this instance I can say that if you had removed the clay gangue from the Butte & Superior feed, that you would have had exactly the same condition as what you had in the Magna first box.

X-Q. 95. Do you think that the quantity of oil necessary to treat an ore is related to the character of the gangue?

A. In many instances, yes.

X-Q. 96. So that in your opinion the ore having some classes of gangue would require more oil than a similar ore with a different character of gangue?

A. Yes.

George A. Chapman.

X-Q. 97. Now I don't know whether you know how Dr. McIlhaney got this determination of the oil on the sharps as distinguished from the oil on the slimes, but if you do I would like to have you answer this question, as to whether, after allowing the pulp of the concentrate to settle for a minute, and then floating off the slimes—whether that did not carry with the slimes all of the detached oil in the mixture?

A. I did not see the operation performed. I will leave that to Dr. McIlhaney.

X-Q. 98. You did not know the conditions?

A. No.

X-Q. 99. I think from what you have said that you can answer this question: Did you or your associates sample or analyze the flowing pulp with the suspended clay gangue separately for oil in the middlings?

A. I don't think those figures are mentioned here, Mr. Scott, and if they are not on this sheet I am afraid that they have not been done.

X-Q. 100. I am referring to the middlings.

A. The middlings returned?

X-Q. 101. Yes.

A. No, I am afraid they have not been done.

X-Q. 102. Then you have no definite data upon which to base the statement that a large amount of that oil was absorbed in and adhering to these clay slimes, have you?

A. I have no definite data, except that one little point on the flow sheet just now, which convinces

me that my opinion is right. If you want me to go into that point I will explain it to you.

X-Q. 103. You may do so if you wish?

A. In describing the returns of these various middling products just now I made the mistake of saying that they were returned to the head of the flotation machine and overlooked the point of these middlings from No. 2 cleaner being sent to the tail race. I was very much surprised and at first I said that was a mistake on the flow sheet, but withdrew the statement. In the whole of my flotation experience I think it is the only example of which I know and have heard of where a middling product from the cleaner is discarded to the tail race. Now, it is perfectly obvious that the only reason for doing that is that the amount of this oily clayey gangue is built up to such an extent in the circuit that it is necessary to discard that portion of that at that point rather than let it go back into the various machines and produce a much lower grade concentrate.

X-Q. 104. Did you, Mr. Chapman, see any of this clayey gangue carrying oil with it?

A. I observed some, yes.

X-Q. 105. At what point?

A. In these various middlings returned. This clay gangue, if you shake it up in water, gives a peculiar streaky color to it, and the presence of oil is certainly shown by the excess of these streaks over the ordinary pulp appearance.

George A. Chapman.

X-Q. 106. Did you make any examination that enables you to say that this clay gangue carries a greater relative proportion of oil, that is relative to the concentrate, than any other kind of gangue?

A. The only thing I can refer you to is these sheets that have been put in evidence which show there is a marked difference shown between the tailing sharp and the tailing slimes.

X-Q. 107. But you don't know how that determination was made, that question I just asked you about flotation over the slimes and whether that wouldn't carry with it all the detached oil and clay with the slimes?

A. Dr. McIlhiny who did these determinations—I have known this gentleman for some time and I know if he did a thing like that he would certainly mention it to me.

X-Q. 108. Are we quite clear about that now? As I understand it there is no flow back to the head of the machine except the tailings from the No. 1 cleaner and the middlings from the lower cells of the rougher machine? That is correct, isn't it?

A. Yes.

X-Q. 109. Now, you have explained the operations at the Butte & Superior which you saw by reference to the clayey gangue slimes, you referred to. Is it your opinion that it would not be possible to practice the process with as large an amount of oil if that clayey gangue slime were absent?

A. You could practice the process if you followed out the process of the Magna mill.

X-Q. 110. Well, suppose we simply eliminate the criticism you make of the Magna mill and carry it out just the way they did at the Butte & Superior mill. Do you think that it would be impossible without the presence of this clay gangue slime you refer to?

A. I should think it would be quite possible to carry out the process, yes.

X-Q. 111. With the same amount of oil?

A. Yes, with the same amount of oil.

X-Q. 112. And the same procedure?

A. Yes, the same procedure.

X-Q. 113. And in the absence of the clay gangue?

A. In the absence of the clay gangue, yes.

X-Q. 114. And it still would be the agitation froth process?

A. Absolutely.

X-Q. 115. I don't suppose you know how Dr. McIlhiney drew the line between the volatile and non-volatile oils that are shown upon exhibit 252?

A. I would prefer to let him describe it, Mr. Scott.

MR. WILLIAMS: We will put Dr. McIlhiney on the stand.

X-Q. 116. MR. SCOTT: Now, referring to exhibit 253, which is plaintiff's exhibit representing the results at the Magna mill during the visit of plaintiff's representatives, will you state whether you think the recovery there shown 97.9 per cent of the copper is a good result, metallurgically speaking?

George A. Chapman.

A. It is a very good result.

X-Q. 117. You have stated that if the Butte & Superior Company were to carry out the process just the same as you saw it on that Sunday of the visit and we were to eliminate the clay gangue slime that that would be the agitation froth process. Do you place any limit at all as to the amount of oil in what would be the agitation froth process?

A. I limit the amount of active oils to what is the agitation froth process.

X-Q. 118. And to what do you limit it?

A. Why, the point of maximum efficiency.

X-Q. 119. You cannot say, can you, Mr. Chapman, that upon the occasion of your visit to the Butte & Superior mill no kerosene or fuel oil coated any of the bubbles or any of the mineral particles, can you?

A. I can't say that, no.

MR. SCOTT: That will be all.

THE COURT: Just point out to me on this flow sheet, exhibit 222, where the concentrates went, those to the cleaners?

A. If you take the specific example shown on this flow sheet, namely No. 1 pyramid, the concentrates are drawn from the first, second and third spitzes on each side and join together and pass through No. 16.

Q. 120. MR. WILLIAMS: Is that an elevator?

A. I assume that is an elevator. And they continue to a point marked 19 and from there enter No. 1 cleaner in the cell marked No. 5. That is true of all

George A. Chapman.

these rougher machines. Now, the concentrates recovered from the first cleaner pass down and pass through pump 23 and from 23 go into cell No. 1 of No. 2 cleaner. The first three boxes of No. 2 cleaner discharge a concentrate which passes to an elevator, No. 17, and from there through No. 20, to the spitzkasten marked No. 5 of No. 3 cleaner. The concentrates from No. 3 cleaner pass and are considered as finished concentrates and are thickened. The tailings from No. 1 cleaner pass~~es~~ to a 36-inch elevator and through junction boxes into the sludge tank and back as shown to the original flotation feed. The tailings from No. 2 cleaner are discharged direct to the tailings race, and leave the circuit at that point. The tailings from No. 3 cleaner pass to elevator No. 16 through No. 19 and back as shown to the feed to the No. 1 cleaner.

Q. 121. THE COURT: The tailings from No. 3?

A. The tailings from No. 3, yes, that is right. The tailings from these various cleaners are considered as middling.

Q. 122. Speaking of this No. 1 cell on the spitz box at the Magna plant, about which you have testified, you say your theory is that this No. 1 box serves as an oil remover. Where does that oil go?

A. That is joined to the main stream of concentrates.

Q. 123. Well, but I understood you to say it wasn't overflowing to any particular extent?

George A. Chapman.

A. Well, the day we were working it was overflowing intermittently, about ten minutes every hour, and the other side, which was a part of the same machine, in the five visits I made to it was overflowing on four occasions, and this overflow joined the main concentrate stream and was distinctly different in color.

THE COURT: Any further questions by either of you of this witness.

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 124. I don't know, Mr. Chapman, that I exactly understood your testimony in regard to the limitations of the agitation froth process to the point of maximum efficiency. That is the way I heard it?

A. Yes.

R-Q. 125. Tell me just what you meant?

A. Well, it is usual in flotation operations to make additions of reagents to give you the best results, and a property—particularly the large properties where the feeds are very constant—this point of best results or as I have termed it before maximum efficiency, is maintained very steadily. There are occasions when something may happen in various parts of the mill that a portion of the feed is turned off or increased, and then comes a time when this condition of maximum efficiency is disturbed. It is then, if your feed is increased and before we have time to increase the reagent, you find that the result is detrimental and the

recovery suffers until you re-establish the proportion of reagent feed to what was the best condition before.

R-Q. 126. And if, on the other hand, your oil supply diminishes?

A. Well, the process suffers again.

R-Q. 127. And that is the point of maximum efficiency, is that right?

A. It is, yes, sir.

WITNESS EXCUSED.

WHEREUPON an adjournment was taken until 10:00 a. m. tomorrow, Friday, May 11th, 1917.

Friday, May 11th, 1917, 10 a. m.

ARTHUR HOWARD HIGGINS, a witness called in rebuttal on behalf of the plaintiff, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Please state your name, residence, age and occupation.

A. Arthur Howard Higgins; age 36; residence London; occupation metallurgist.

Q. 2. Please state your education and qualifications as a metallurgist, with special reference to the froth flotation process.

A. I received my education at the Bradford Technical College, followed by a course at the Royal School of Mines, where I graduated in 1901; in 1902 I was

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assistant demonstrator in mineralogy and geology. At the end of 1903 I joined the Minerals Separation Company's staff.

Q. 3. How long have you been engaged in the study of the air froth flotation process?

A. I have been engaged in the study of the air froth flotation process since its discovery in 1905.

Q. 4. And what has been the nature of your work during that period of 12 years?

A. Chiefly in the development and improvement of the air froth flotation process; largely in the laboratory and occasionally in the mill.

Q. 5. You made an estimate when testifying in the Miami suit that you performed about 20,000 operations under the process of the patent here in suit. Do you accept that as a fair average of those operations up to two years ago?

A. Yes, I do.

Q. 6. Since that time have you continued your study of operations in regard to this process?

A. I have.

Q. 7. And, as I understand you, for the past twelve years you have been continuously engaged in the study of this process? Is that right?

A. Yes, that is correct.

Q. 8. Have you studied and are you familiar with the Everson patent No. 348,157, of August 24, 1886?

A. Yes, I have studied that patent and have been familiar with it for some time.

Q. 9. You might tell us when your attention was first called to it and under what circumstances.

Arthur Howard Higgins.

A. My attention was first called to this patent about the end of 1904 when Mr. Sulman brought the specification into the laboratory and we discussed it together and then he asked me to make a repetition of the example on page 2.

Q. 10. Known as the Everson, what method?

A. The Everson first method. The operation was carried out according to the details she gives in the specification and we got a successful result.

Q. 11. Since that experiment carried out by you in 1904 have you repeated the operations of this first method? And if so, about how many times?

A. I have repeated that operation~~s~~ since then a good many times; I think somewhere between fifty and one hundred.

Q. 12. Is there any characteristic about that operation as to whether you fail or succeed?

A. Yes, but I don't know what exactly that characteristic is. Some detail in making the compound of the oil, and acid, which is not given in the description; for the success or failure of the operation seems to be a mere matter of accident, whether one gets a good result or a bad one.

Q. 13. Well, about how many times have you succeeded and how many times failed?

A. I suppose in fifty times I have succeeded about twenty and failed thirty.

Q. 14. When you carried out this operation in 1904 what apparatus did you use and what instrumentalities?

Arthur Howard Higgins.

A. For mixing the compound, we had an evaporating dish, spatula, barrettes and things of that kind, and for the washing out operation we used an ordinary hand basin containing water, squeezed the pasty or plastic mass through the hands so as to open it out in the manner in which she suggests.

Q. 15. And is that or is that not the mode of operation described in the specifications?

A. Yes, that is the mode described.

Q. 16. In that operation do you ~~put~~ first produce the "stiff mass" referred to on page 2, line 36, of the specification?

A. Yes, one always gets the stiff mass; that is very easy. The difficulty in the process in the cases where it fails is where the stiff mass does not remain sufficiently plastic in the water so that we cannot get the pasty mass or lump or lumps that she refers to in lines 65 to 68 in the specification.

Q. 17. Now, there is a statement in the specification as follows: "In treating so small a bulk as above specified, the mass may be squeezed repeatedly in the hand in a basin of water, the substance, so manipulated being expressed between the fingers each time it is squeezed, and thus made to expose new surfaces to the water, from which the sand will be detached so as to fall to the bottom of the basin." That is the description, is it not?

A. That is the description.

Q. 18. Now, following that is the statement in line 60: "In practice upon large masses, any vessel having

an outlet or outlets at its bottom for the escape of the water and sand will be suitable for this operation of washing, and mechanical means will, of course, be employed to break up the mass. The concentrated material will accumulate in a pasty mass or lump or lumps and will contain the metallic portion of the ore, together with the hydrated oil and acid, which oil may be removed by heating and afterwards roasting or by other suitable means." What have you to say as to that part of the specification, referring to the operation on large masses through the employment of mechanical means to break up the mass and the recovery of concentrate in a pasty mass or lump or lumps?

A. This portion is what one might call a method of unkneading the stiff mass which we previously obtained, but I know of no machinery—I could not find any machinery which I thought would be suitable for that purpose. It is not exactly like the ordinary kneading operation, in which dough is made, and for which dough making machinery is particularly applicable. It is the reverse of this; one has to open the mass so the interior is coming out constantly to the exterior, to give the sand a chance to become detached. The condition of the concentrated mass I read as applying to the whole of that method; it is not applied only on a large scale; it is applied just as much in this laboratory example.

Q. 19. Have you made any study of the literature for the purpose of trying to find if there was any apparatus disclosed and known at that time capable of this use?

Arthur Howard Higgins.

A. Yes, I have made that examination, and the only thing that I found were pug mills and mortar mixers such as Haynes used, and those are not satisfactory for this purpose.

Q. 20. It has been stated in the testimony for the defendant that this Everson patent discloses the conjoint use of sulphuric acid and sulphate of copper. What have you to say as to that?

A. I find no disclosure of the conjoint use of any acid and salts or acid and acid salts. The disclosure is of an acid or of a salt; there is no disclosure of copper sulphate or copper chloride being used in connection with acid or in combination with acid.

Q. 21. What is an acid salt?

A. It is a salt in which the hydrogen is only partially displaced by the metal; a common example would be the acid sodium sulphate.

Q. 22. That is, it is a compound which may be said to consist of sulphuric acid and sodium sulphate combined together in one compound, so that it is partly salt and partly acid, is that right?

A. Yes, that is true.

Q. 23. In the description of the Everson patent what reference do you find as to the applicability of the process to an ore containing clay?

A. The specification is very explicit on that, beginning line 29, page 1. It says: "The invention is more specially applicable to the treatment of ores in which the metal or metallic portion is mixed with quartz or other rock, as distinguished from mineral mixed with

slay; though it is applicable to ores containing alumina together with quartz or other rock, to the extent of permitting the removal of the silica or sand." The silica or sand of course is quartz. The specification in a good many places refers to the removal of this quartz or rocky gangue. There are 12 references to the gangue in this specification, in all of which she refers to the gangue as quartz or rocky gangue.

Q. 24. Now, as to the Everson second method, have you tried to carry it out a number of times?

A. Yes, I have.

Q. 25. How did you try to carry it out at first?

A. In the first trials of this method we tried to carry this out with an agitator to thoroughly detach the sand from the mixture, followed by a spitzkasten to attempt the separation of the concentrates, under the impression that the process was more or less a reversal of the Cattermole procedure.

Q. 26. And in what manner was the spitzkasten used?

A. One might say that one uses the spitzkasten upside down, instead of taking the concentrate off at the bottom, we took the concentrate off at the overflow and we removed the sand at the bottom.

Q. 27. And did you have any success in that kind of an operation?

A. None at all.

Q. 28. There are operations described in the Hyde record, one of them in which the so-called concentrate contained less mineral than the original ore and the

Arthur Howard Higgins.

so-called tailings contained more mineral than the original ore; is that a fair example of what you got?

A. Yes, that is a fair example.

Q. 29. And when, and under what conditions did you attain a reasonably successful operation in the concentration of ores in accordance with this second method of Everson?

A. In the use of this spitzkasten or classifier to separate the material, it became evident that the thing was not useful for that purpose, and, referring to the use of the spitzkasten in the art at that time, it was quite evident that that spitzkasten in the wet concentration of ore was never used for the separation of mineral and sand. By following that line of reasoning we came to the conclusion that—Dr. Liebmann and I were studying the proces at that time together—that the proper method to use was to adopt the same separating device that they used, that is, the shaking or bumping table, or the vanner, and on the table we have the constant overflow of water which carries away the lighter portions of material that is fed into it and the heavier portions coming off the end of the table. For that reason we took the batea, which is one of the laboratory instruments which reproduces the action of the bumping, shaking or vanning tables.

Q. 30. And the batea also happens to be what sort of an appliance in the art?

A. That is a washing out vessel which is frequently used for the separation of gold from auriferous sands.

Arthur Howard Higgins.

Q. 31. Did you discover any coincidence between the proportions disclosed in the Everson specifications and the contents of a standard batea?

A. Yes, the quantity of ore which she states as being abundantly moistened by the three fluid drams of oil is two ounces; and this two ounces is a very satisfactory quantity to handle in a batea, so the method appears to me to be suitably carried out and I think properly interpreted by the use of a batea.

Q. 32. And when the batea is used and the material is flowed over to the edge of the batea is it or is it not a fairly successful metallurgical operation?

A. Yes, it is a fairly successful operation.

Q. 33. Recoveries having been about what, in the experiments that you have made?

A. I think I had the recovery as high as 80%.

Q. 34. Now, I will ask you to perform, first an experiment using the batea with ore and no oil, just ore and the water. Under those conditions what would happen?

A. One gets the lighter material carried away from the heavier material, it flows off in the water.

Q. 35. And the lighter material is what?

A. The lighter material being the sand.

Q. 36. Now, when you use the oil in the proportions disclosed by Mrs. Everson, what then happens?

A. Then you get exactly what she tells you you will get, the transposition of the mineral and the oil with the sand; that is to say, the mineral and oil become

Arthur Howard Higgins.

lighter than the sand and they are washed off with the water in the same position as the sand was previously washed off.

Q. 37. I read you the language of the specification, commencing on page 2, line 108: "Bearing in mind that the sand and mineral are merely transposed, or their relative positions are reversed, because the sand is heavier than the mixture of mineral, oil, and acid." Please state whether that is a description of what takes place.

A. That is an exact description of what one finds.

Q. 38. Now, will you carry out the operation without the oil and then show us the reversal of that operation with the oil; you may describe what you are going to do now.

A. In the first operation I am going to take 57 grams, that is, two ounces, of the -35 mesh feed to the Wilfley table from the Anaconda plant. The reason that I have had the plus 35 mesh sifted out from this material is that it is too coarse to handle on the batea.

Q. 39. And this material that you are taking is the feed to the shaking table, is it?

A. Yes, feed to the shaking table.

Q. 40. The operation that you will perform will represent the operation of a shaking table? Is that right?

A. Yes, it will.

Witness performs the operation.

A. These are the concentrates resulting from the vanning operation.

Arthur Howard Higgins.

THE COURT: Of course that is simply an experiment; not what is in the patent.

MR. WILLIAMS: This shows the ordinary operation which the patent reverses.

Q. 41. THE COURT: This is what?

A. That is the ordinary operation in which the sand is overflowed and the mineral remains in the vessel.

MR. WILLIAMS: Now, if you wish to cross-examine, Mr. Scott.

CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 42. Is the procedure which you just carried out, the batea, so far as manipulation goes, the procedure which you construe as being described by the words in the Everson patent, "a constant overflow of water?"

A. Yes. As I understand the "constant overflow of water" is the overflow of water which occurs on the side of the bumping or shaking or vanning table. The batea is not operated in exactly the same manner. Usually one does not have an assistant to keep a flow of water running over the batea the whole time. The operation is generally carried out by dipping the batea into the dish or the lake or whatever you have to wash with, and it overflows intermittently.

The same sort of an operation as produced on this batea can be produced on a Wilfley table, and this is done in thousands of instances in examining any kind of

P. 4469, L. 23, after " operations " insert " what she thinks ought to be used in large scale operations,"

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a prospect. I am convinced that the batea does represent the vanning table, bumping or shaking table.

X-Q. 43. The flow of water from the batea as you represent it was merely an intermittent flowing off or slopping off of the water, was it not, as you did it?

A. The flow stopped occasionally, yes; that is true. That does not alter the operation of the process in any way.

X-Q. 44. You consider that the manipulation you just carried out meets the words "a constant overflow of water" as well as a settling box or spitzkasten with a current of water coming in at the bottom and overflowing at the top constantly, as stated in the patent?

A. The device that she refers to "devices and methods now well known" and the apparatus that she requires is not the specification of the apparatus that she tells you to use in the laboratory experiments. She finishes, in the paragraph before, with regard to the laboratory experiments; She leaves you to carry that out in a way which every metallurgist would be able to find out easily. The constant overflow refers to the large scale operations or such vanning, shaking and bumping tables as were then in existence.

X-Q. 45. What is there in this patent that leads you to think that a constant overflow of water referred to something like a batea rather than a spitz box with a really constant overflow of water coming in at the bottom and going out at the top?

A. First of all you have to consider the fact that

she says, "the mineral and the sand are transposed." Now, to start with you must transpose them back again to their original position, with the sand lighter than the mineral. Now, the devices which you take for that separation are not spitzkastens or classifiers. They had never been used in the art for separating mineral and sand. The devices which are used are the shaking table and the bumping table and the vanner, and for very coarse stuff, one uses jigs. So, when you come to the transposition, there is no reason whatever why you should not take the same transposed stuff and treat it on the same apparatus.

X-Q. 46. How about the separation of the heavy material from the light material in the upcast of the Cattermole process; isn't that an instance?

A. That was an instance where an upcast was used very much later than the Everson specification; it was not used for that purpose before the Cattermole patent was published.

X-Q. 47. What is a spitzkasten used for except to separate lighter or finer material from coarser and heavier material?

A. It does not separate light or coarse material from heavier or finer; the spitzkasten separates material according to its falling power in water. If we take galena and sand and grind them up together and put them in water and mix them, and then classify the pulp, it will separate according to its falling power in water; you do not get any separation of galena from the quartz; ~~you~~

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~~do not get any separation of galena from the quartz~~; in one box of the classifier you would probably get very light sand mixed up with some much finer galena, and as you go down you would find that in each case you have got a mixture of quartz and galena, the only difference being their actual size.

X-Q. 48. How about the patent in suit? It shows spitz boxes with upcasts in the water for the purpose there stated of carrying upwards the float or froth and sinking the finer slimes in one spitz and the coarser slimes in another and the sands in another?

A. The patent in suit is dealing with something that was not known at the time of the Everson specification, and I have referred to the use of these pieces of apparatus at the time of the Everson specification.

X-Q. 49. And you base your use of the batea simply on your assumption that the Everson process resulted in something different from the patent in suit, and proceeding on that assumption you proceed with this program of experiments?

A. That is not an assumption; that is what I find from a study of these specifications.

X-Q. 50. It is your conclusion?

A. It is my conclusion, and I think I have support from the fact that I can get results from the batea when I cannot get them from the spitzkasten.

~~X~~-Q. 51. MR. WILLIAMS: You were asked about the use of the spitzkasten in the days of the Everson patent, and you did not tell us what the overflow

from the spitzkasten was in the days of the Everson patent?

A. In the days of the Everson patent the overflow from the spitzkasten was a large amount of water carrying a good deal of slimy material, both mineral and gangue. In those days it went to waste.

Q. 52. And it was known as what sort of a device in mineralogy?

A. Simply a classifying device, to obtain material suitable to be treated in what we call hindered settling operations; that is, the operations that are carried out in jigs, bumping tables and shaking tables.

Q. 53. And in the days of the Everson specification was there an upcast classifier resembling in its construction the Cattermole upcast?

A. No; in those days the classifiers differed somewhat. They all opened outward as they went up to the upper part, so that you got a different flow of water in every part of the vessel; the overflow being greatest at the bottom and decreasing gradually toward the top of the vessel. Otherwise the principle was the same.

Q. 54. Now, just one thing more. In that operation which you carried out in the batea did you or did you not exactly reproduce what the gold miner does in panning his sands?

A. The gold miner does it exactly in the same way.

Q. 55. And where does he find his nuggets?

A. He finds the nuggets in the tip of the hollow.

Q. 56. That is, in the pan after he has washed them out?

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A. After he has washed out the sand. The sand goes away from his body, and the gold remains on that part of the pan that is nearest to his body.

Q. 57. Now, I will ask you to carry out the Everson second method in a batea, and first, before you start, tell us what you will do?

A. I shall take a small quantity of the same ore, that is minus 35 mesh of the Wilfley table feeds at the Anaconda plant, and mix that with 11 c.c. of engine oil, which is 17 per cent of oil to the ore; and having mixed them together, I shall agitate the mixture in acidified water, which has point two per cent of sulphuric acid; and having agitated thoroughly, transfer it to a batea, and wash it in the same manner that I washed the ore without any oil.

(Mixing ore and oil.)

That is, I have mixed the oil with the ore and made a moistened mass.

Q. 58. State whether or not you have thoroughly mixed them?

A. Yes, I have thoroughly mixed them. Now, I have added to that some acidulated water, and with the assistance of the water I will carry out the washing process. Now, I am agitating the moistened mass so as to mix it with the acid water.

Q. 59. You are thoroughly agitating it, in the light of the days of the art of Everson?

A. Yes, in that light I am thoroughly agitating it.

You can see by the gray color of the water that the gangue is coming out of the mixture.

Now, I have transferred that to the batea, and I am going to wash it the same way as I washed the other. I would like to show your honor the transposition of the sand and the mineral.

Now, you see the sand remains at the bottom, and the mineral is moved forward by the flow of the water.

Q. 60. Now, what is left in the batea?

A. At this time the sand remains in the batea. Of course there is a little pyrites which has fallen away from the compound of the oil and the mineral.

Q. 61. And in the other operation what was left in the batea?

A. The mineral was left in the batea in the other operation.

Q. 62. And the sand?

A. And the sand was all gone.

This is the overflow or the lighter portion which I show your honor in the big pan, which consists of the mixture of oil and mineral.

MR. SCOTT: Before passing this I would like to call the court's attention to the amount of mineral there in the batea. He said the mineral was washed away, but there is some there.

MR. WILLIAMS: It was not a one hundred per cent operation.

Q. 63. You will supply specimens of this operation for assay?

A. Yes.

Q. 64. Now, this operation that you have just per-

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formed in court, have you performed it many times.

A. Yes, I have.

Q. 65. And have your results been generally successful or not?

A. Well, the results vary somewhat. If you take an oil that has great viscosity you can get an excellent result as far as the recovery goes, but you are liable to include some of the sand with the mineral and so get a low grade of concentrate. If, on the other hand, you take a thinner oil, you get a very high grade concentrate, but some of the mineral drops out of the oil combination, and it stays in the place where it should on the table, and of course that goes in with the sand in that case.

Q. 66. How do the results of this operation that you have just performed compare with the best that you can do in a spitzkasten overflow or upcast such as you have tried before you tried this?

A. I am convinced that this result could be repeated on a large scale and you could get satisfactory treatment by agitating it. On the other hand, if you take a spitzkasten it would be a hopeless affair; one could not possibly obtain any satisfactory results of any kind whatever.

Q. 67. So that this is the only way that you have been able to carry out that second method and obtain fairly good results, is that right?

A. Yes, that is correct.

Q. 68. And what is your opinion as to whether or

not what you have done is the particular thing that Mrs. Everson discloses in her specifications?

A. I think I have done everything which she discloses, except perhaps I have not taken an ore that did not contain any alumina. This ore does contain some alumina, and for that reason it might be somewhat less satisfactory than what one might obtain with clean white quartz. I would like to point out that the method using the batea in both the vanning operation and the other operation when I was repeating the Everson was the same. There was no difference in any movement, except perhaps that at one time the batea went around a little further than at another time perhaps, but in each case the lighter stuff was washed off by the operation of the batea furthest from the body of the operator and the heavier stuff remained behind in the batea itself.

Q. 69. Now, in the first operation the sand was washed over the edge of the vessel?

A. Over the edge of the batea.

Q. 70. Did it float off?

A. No, not in the true sense of the word. In the metallurgical sense, particularly at that time, the sand was floating off.

Q. 71. But in fact the sand didn't float?

A. No, in fact the sand did not float, it was carried in suspension in the water.

Q. 72. And was it or was it not heavier than the water?

A. Yes, the sand is heavier than the water.

Q. 73. Now, in the Everson second method as car-

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ried out in the batea what was carried over the edge of the vessel?

A. The mixture of oil and mineral.

Q. 74. Was this mixture of oil and mineral heavier than the water or lighter than the water?

A. Heavier than the water.

Q. 75. Did it float?

A. Not in the strict sense of the word, but in the metallurgical sense used at that time, it floated.

Q. 76. And how was it in fact carried over the edge of the vessel?

A. Well, in fact it was carried over in suspension.

Q. 77. When material is carried in suspension by a flow of water, may or may not that material be sinking in the water as it is carried?

A. Yes, that is usually sinking, sometimes very slowly, but it must sink at some rate.

Q. 78. Can you find any references in the literature of the days preceding the Everson patent as to the use of the word "floating?"

A. Yes, I have some references, page 355 of Ure's Dictionary of Arts, Manufactures and Mines, published in 1860, in describing Brunton's machine says: "The heavier particles lodged on the cloth, are caught in the waggon, R. whilst the lighter matter is floated over the roller M."

Q. 79. Now, what was described by the words you have just quoted, "the lighter material is floated over?"

A. That is a description of a separating operation

which is the counterpart of the operation with the batea which I have just shown.

Q. 80. "The lighter material is floated over," is the sand and slime, in suspension in the water?

A. Yes.

Q. 81. Now, can you give me another reference?

A. On page 330, under the heading of "separation"

Q. 82. Read the sentence.

A. The book is describing the principles of a separator. "The prevailing principle is that of directing a pressure of water against the density of the descending material, making the former sufficiently powerful to float off certain minerals with which ore may happen to be associated." That use of the word "mineral" there includes the gangue. It is not used to designate only "metalliferous mineral."

Q. 83. And the use of the words "float off" there describes what?

A. That is exactly the same operation, the removal of the lighter portions of the stuff in suspension in water.

Q. 84. Have you another refernce?

A. 352.

MR. SCOTT: I want to call the court's attention to the fact that even with this mild manipulation, particles are coming to the top, and with a magnifying glass the bubbles can be seen, even under the limited manipulation that was given to it in this experiment.

At the bottom, little bubbles, shining, can be seen,

P. 4479, L. 31, insert "Q. 91. What have you to say as to the significance or"

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and by looking at the thing closer when it is turned a little, every little while one of these will rise up and there is quite a coating of them on top as it is now.

Q. 85. MR. WILLIAMS: In other words, it is a floating froth?

MR. SCOTT: I am calling attention to the fact that even under the restricted agitation which was given to it, the tendency to rise was ~~can~~ not ~~be~~ defeated.

Q. 86. MR. WILLIAMS: You have heard the remarks of counsel, Mr. Higgins?

A. I have.

Q. 87. Will you testify as to what the facts are?

A. The facts are that there is less than one per cent of the material floating. I think I might say with a great deal of truth it is less than one-five-hundredths part of it floating.

Q. 88. And what do you attribute that float to, in the bottle into which the material was dumped?

A. I think at least one-third of that is floating by surface tension. A great deal of the float is due to the buoyancy of the oil, and there are some air bubbles in it.

Q. 89. Is it or is it not a fact that the water that you used, Butte water, is saturated with air?

A. Yes, we used water saturated with air and we put sulphuric acid into it. It is possible there may be a small quantity of calcite in the ore which would generate bubbles of gas.

Q. 90. How was the material put into this bottle?

A. ~~I think it was washe ddown through a funnel.~~

A. I think it was washed down through a funnel.

~~on~~ the metallurgical value of anything that can be said to be a float on that bottle?

A. It is of no significance whatever. It means that you lose a little bit of the stuff. That is all. It is absolutely of no metallurgical value.

Q. 92. Please continue your answer.

A. Under the heading "Percussion Table, or Stossheerd," "The stuff to be washed—" that of course is the ore—"is placed on the chest (a), into which a current of water runs. The ore, floated onwards by water, is carried through a sieve on a small sloping table (x), under which is concealed the higher end of a movable table, (d), (b), (c), (u); and thence falls on this table diffusing itself uniformly over its surface." The illustration here is very much to the point because the description is of a bumping table which Everson evidently intended to use and the same term is used "floating" where it refers to the material carried in suspension over the table. I have another quotation on page 362 under the heading "Slime Pits." "In the several operations of cleansing ores from mud, in grinding, and washing, where a stream of water is used, it is impossible to prevent some of the finely attenuated portions floating in the water from being carried off with it."

Q. 93. Now, as to this last expression, "floating in the water." In the first place, what does that refer to; what sort of an operation?

A. That refers to the washing of ores to get rid of

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the clay or slime material that has been formed during crushing of the ore.

Q. 94. And what is the material which is said to be "floating in the water" in this description?

A. It is referred to, I think, as slime, "some of the finely attenuated portions"—that means some of the stuff that we call slime, the very finely crushed material.

Q. 95. Where slime may be described as floating in water, how would you accurately describe it?

A. As being carried in suspension.

Q. 96. Now, in connection with the Everson specification, Dr. Sadtler discovered a third method of Everson as described in the paragraph on page 3, lines 17-24. What have you to say as to the disclosure of the specification at that point?

A. The method there disclosed is exactly the same as the second method, the only difference being in the kind of oil used. I have tried that proceeding with the smaller quantity of oil which is disclosed in the first example, that is 4.97% of oil. I used cottonseed oil for that experiment, and I found that it was impossible to make the stiff mass which she tells you to produce in line 36, page 2 of the specification. On putting the very dry sort of powder into water and attempting to manipulate it in the manner that she further described in line 53 of the specification, page 2, it was impossible to make the plastic mass which is requisite in carrying out the example. If one takes the quantity of oil that

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is described in the use of the second method, that is, 17.1%, then the process works exactly as the process where you use petroleum or a constituent, so that the disclosure is the same as the second method, what we call the second method, the only difference being the matter of the oil.

Q. 97. And what oil did you use?

A. Cottonseed oil in both cases, both these tests that I referred to just now.

Q. 98. Cottonseed oil, is that the oil of the first method?

A. That is the oil that she tells you to use in the first method.

Q. 99. If you were to repeat that operation with cottonseed in the same proportion that the paraffine oil was used, would the operation be just as you have demonstrated in court, or what?

A. The operation would be exactly the same; I don't think anyone could see any difference by observing the operation, or any difference in the results.

Q. 100. I don't think you gave the specific gravity or the description of the oil that you used in your second Everson demonstration.

A. The oil that I used was a constituent of petroleum known as engine oil having a specific gravity of .88. There was no particular reason for choosing any particular oil in that case. The quantity of oil which she gives is rather indefinite. She says three fluid grams of a 30° Be. petroleum—which of course is crude oil—

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is sufficient for properly moistening two ounces of heavy ore. She does not tell us what properly moistening means, or what the heavy ore is, but that quantity of oil seems to give the required result. It might be possible that one could get a better result by taking a little more oil.

Q. 101. What percentage of oil did you use?

A. I used 17.1%.

Q. 102. And is that your computation as to the disclosure?

A. That is the computation as to that disclosure I just referred to.

Q. 103. Dr. Sadtler referred to the description on pages 356 and 357 of Ure's Dictionary and the illustration on both pages showing what is entitled a Dolly tub, or packing kieve. Can you give us any information as to the kind of an agitator disclosed in connection with the Dolly tub in that publication?

A. The Dolly tub shown on page 357 is described as a machine Dolly tub. The size is very large. One sees the tub sitting on a railway car. The machine is geared from a water wheel in the ratio of one to one. The water wheel, of course, is a very slowly moving wheel, turned by water, so that the agitator inside the Dolly tub will make about the same number of revolutions as the water wheel does, probably four or five a minute. The hand Dolly tub shown on page 356, Figure 1419, is rotated by a couple of men by hand. Seeing that the load in that agitator practically fills the tub

when the agitator is withdrawn, it is quite certain that such a rotation by a couple of men would be a very slow process. On page previous to this, 355, there is given at the end of the description of Brunton machine, another machine-driven dolly. There is a great deal of detail given with that drawing as to the length of the belts and the rates they go at, so that by making one or two measurements it is possible to find out that that agitator inside the dolly runs from 4½ to 7 revolutions a minute.

Q. 104. Dr. Sadtler called attention to an illustration at page 332 of Ure's Dictionary, Fig. 1379, and Fig. 1380, showing a spitzkasten. Have you anything to add to what you have already said in regard to that spitzkasten?

A. No, there is nothing to add to that. The separator here is not for separating mineral from gangue, but for separating different classes of mineral and gangue.

Q. 105. And particularly what material would overflow from that spitzkasten?

A. Very fine material, consisting of both mineral and gangue, what we call slime.

Q. 106. Then on page 335, Fig. 1385, there is another arrangement which was referred to by Dr. Sadtler. What is the function of that apparatus and for what was it used?

A. That was an apparatus which was designed to separate powdered ore into five different sizes of material, four of them descending through the pipes K, L

and M and N, and the fifth overflowing at the lip of the spitzkasten. This material, as before, consisted of mixtures of sand and gangue and mineral.

Q. 107. What do you call such an apparatus?

A. A hydraulic classifier.

Q. 108. And what material would overflow from that spitzkasten?

A. The finest material, the actual size of the material overflowing depending on the amount of water you turn into the apparatus at the valve G.

Q. 109. What would you call the material that overflows?

A. Slimes.

Q. 110. And in those days what became of those slimes that overflowed?

A. In those days they were run to waste.

Q. 111. Do you find in the Everson patent, No. 348157, any disclosure of a froth-producing process?

A. No, there is no such disclosure in the specification.

Q. 112. Do you find disclosure in the Everson specifications any procedure whereby a mineral froth is produced?

A. No, I do not.

Q. 113. Now, we will take up the Fryer Hill publication. Have you studied the exhibit known as the Fryer Hill publication which appears in complainant's record in the Hyde suit, pages 738 and 739?

A. Yes, I have.

Q. 114. Do you find here disclosed the particulars of a process which will enable you to carry it out?

A. No, there are not sufficient details to enable anyone to carry out a repetition of this experiment which is reported.

Q. 115. What are your general conclusions as to the thing that was intended to be described?

A. The description is of some experiment that was made and the results obtained were said to be very satisfactory. In the first instance the operation was carried out on a silver ore that ran over ten ounces of silver. It says that the ore was crushed to enable it to pass through a 40 mesh screen. Of course the operation of crushing in those days, when the slime went to waste, where nobody was able to do anything with it, the operation of crushing was to do it to the end that the minimum amount of slime was produced and that the maximum remained in the coarsest possible degree. There the coarsest possible degree was, of course, 40 mesh. The ore was then mixed with the oil whilst dry and placed into some kind of a tank having a pipe in it, or hollow tube, to which was attached a couple of fans. The action of this tube with two fans at the bottom was described as being "arrastra-like." The arrastra-like fans attached to the bottom of the tube kept the whole mixture in motion. That was exactly the same kind of motion that is referred to in the action of these dollies illustrated in Ure's Dictionary, what we should term now as gentle agitation. Acidulated steam was

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forced from the pipe whilst the ore was kept in motion, and during that time the lighter portions of the mineral-charged oil floated to a point just above the center of the receiver ~~reservoir~~. The article that the reporter is dealing with here is oil containing mineral, and it has to float during the operations to a point just above the center of the receiver. That is another reason why the operation should be carried out in a gentle mode of agitation so that the stuff that does ~~not~~ float is not carried down again violently to the bottom of the tank and thrown in all directions.

Q. 116. What about the metalliferous content of the ore that was treated?

A. Well, the ten ounces of silver might account for the whole of the mineral in that ore, in which case it would be extremely low metal content. And the fact that this oil containing the mineral floated during the operation seems to indicate that there was a very low mineralization of the ore and it was able to carry the whole of the mineral in the same fashion that the Elmore oil carries the mineral in his operation.

Q. 117. That is to say, there was very little mineral to float?

A. In my opinion there was very little mineral to float.

Q. 118. And what, so far as you can gather, were the flotative agents or was the flotative agent employed?

A. Petroleum. That would be crude petroleum. I

don't find any other flotative agent. The steam would collapse in the water. That wouldn't be any flotative agent.

Q. 119. And if the oil was the flotative agent, in what manner would the oil exercise flotative powers; as a result of what?

A. Simply by reason of its buoyancy.

Q. 120. Can you read out of that description any utilization of air bubbles to float the mineral?

A. No. On the contrary air was not introduced by the agitation in this process to any extent, because the description given indicates that the fans attached to the bottom of the tube were rotated very slowly, and in fact they are described as "arrastra-like." They were dragging in the ore which had settled at the bottom of the tank. It is also apparent that it is possible that the oil was being removed at the same time that the agitation was going on, which would be of course impossible if you used the high speed of agitation of the modern art.

Q. 121. Do you find any disclosure there of a rapid, violent agitation, followed by a settling operation giving the material chance to settle?

A. No. On the contrary, I think the indications are the exact reverse of that.

Q. 122. THE COURT: How much oil is mentioned in that publication?

A. There is no quantity of oil given your honor. The ore was crushed and mixed with the oil and it

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does not say what condition the mixture was in after the oil had been added, either.

Q. 123. MR. WILLIAMS: So that you have no proportions there, no direction. No proportions to guide you?

A. No, none at all.

Q. 124. And when you refer to the buoyancy of the oil, what sort of a proposition would it call for?

A. Well, if the mineralization is low, then that amount of oil referred to in the Everson experiment, 17%, that would be ample oil to float the silver by the oil buoyancy method.

Q. 125. Now, a machine has been produced in court and is in evidence as Defendant's exhibit Fryer Hill machine. Have you examined that machine?

A. Yes, I have.

Q. 126. Is that machine described in the Fryer Hill publication?

A. It is not.

Q. 127. Is the operation to which that machine was subjected in the experiments in court described in the Fryer Hill publication?

A. No, the operation is not described. As I already have pointed out, the operation seems to be exactly the reverse.

Q. 128. Now, there was another machine that was offered in evidence known as the Cataract machine; this machine being said to have been made from a drawing and description appearing in a book by Louis

Edgar Andes. Have you had a drawing made contrasting that exhibit, Cataract machine, with the drawing shown in that publication?

A. Yes, I had the machine carefully measured and drawn and the illustrations put side by side so as to visualize the extension of the machine in depth.

Q. 129. Now, the drawing to the right, is that the defendant's cataract machine?

A. That is the defendant's cataract machine.

Q. 130. And the drawing to the left?

A. Is the drawing from the illustration from Andes on the same scale.

Q. 131. What is the significance of that great addition to the height of the machine which has taken place in defendant's reproduction?

A. The significance there is that the increased depth in the machine makes it possible to use a much higher speed of agitation. In the operation of that machine as I saw it here, the liquid was extending for half an inch or three quarters of an inch above the disc.

Q 132. Above the rotating disc as shown in the drawing of defendant's cataract machine?

A. Yes, referred to as "this cover." Now, if that same rotation had taken place in the actual machine made according to the illustration, there would have been a tremendous loss of material; it could not possibly be run at that speed.

Q. 133. It would overflow from the edges would it not?

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A. Yes, it would have come over the top.

MR. WILLIAMS: Drawing produced by the witness offered in evidence and marked defendant's exhibit 254.

Drawing admitted in evidence and marked DEFENDANT'S EXHIBIT 254.

Q. 134. I call your attention to exhibit entitled complainant's exhibit, Criley Everson publication, appearing on page 740 of complainant's record in the Hyde suit, and ask you if you have studied that publication?

A. Yes, I have.

Q. 135. Does it or does it not disclose such particulars as will enable you to carry out the process?

A. In my opinion it does not.

Q. 136. What is the significance of that part of the description which says: "A thick scum of sulphurets rose to the surface and was skimmed off, leaving the hitherto black ore as white as snow—in fact pure silica."

A. That was some floating material which was obtained on the surface of the water, which must have consisted of some part of the ore which is called there sulphurets, being the old word for sulphide, mixed with oil. As to what it was exactly, whether it was an oil layer or not, I cannot tell you, or whether it was a froth.

Q. 137. Is the word scum descriptive or not of the Elmore float?

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A. Yes, scum is used for oil floating on water.

Q. 138. Now, we will take up the Kirby patent, No. 809,959. In the first place it has been said that Kirby discloses an operation of agitation and froth separation, and that everything else in the specification is supplemental thereto. What have you to say as to that?

A. That is not so. The process described on page 1 of the specification consists of four steps, but the operation as carried out is very clearly seen in figure 1 of the specification. There the ore and water, with the oil mixed together, in tank "A." There is no provision at all in that tank for taking off anything whatever except through that small pipe which comes out of the right hand bottom corner. You could not possibly take off any floating material at all; it must be the mixture of oil and ore and water which we call the pulp.

Q. 139. In the operation of that tank the material flows out at the bottom?

A. Out at the bottom.

Q. 140. What does the wave like dotted line at the top of the drawing suggest to you?

A. It suggests that the thing is rotated gently?

Q. 141. And when you use the word "gently" just what do you mean?

A. Well, that would be called agitation in the prior art; we should not call that agitation at the present day; we should not call that agitation at the time of Cattermole. The surface of the liquid, if it

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were in violent agitation, would, I think, be drawn quite differently.

Q. 142. Passing from the thing that drawing indicates to the language that Kirby uses in his specifications, how does he describe the agitation that takes place in tank "A" described in the specification as the mixing tank?

A. Well, he calls that "thorough agitation" or "thoroughly agitated."

Q. 143. And does he state the purpose and function of that agitation?

A. Yes; that is to break up the oil into globules. That is to say, in contrast to the Elmore process, where the oil is not broken up; so that all he needed was slight agitation that was a little bit more violent than Elmore.

Q. 144. And having in mind the fact that in claims 1, 2 and 3 of Kirby the words "violently agitated" are used as descriptive of what takes place in the mixing tank "A," and the words "gently agitated" are those used as descriptive of what takes place in the separating tank B—did you have that in mind?

A. Yes, I had that in mind.

Q. 145. And what is its significance to you?

A. That the agitation in tank "A" was considerably more violent than in tank "B." In tank "B" the agitation would be extremely gentle, so as not to break the surface of the pulp.

Q. 146. Now, you have said that in the mixing tank "A" nothing is taken from the surface?

A. No, there is no provision for taking anything from the surface there.

Q. 147. And in a continuous operation, would it or would it not be possible to take anything out, any flow from the surface?

A. It would be impossible.

Q. 148. Now, the separating tank B, what is the function of that tank?

A. That tank is a tank that is specially prepared for separating the layer which comes from the pulp when it gets into this region of lesser agitation. The separating tank has an agitator which carries with it air pipes and oil pipes, which are shown in figures 4 and 5. There in the separating tank you have the pulp coming in through the small pipe just below the surface on the left hand side, with streams of air and oil coming in through the agitator, which have to rise to the surface. That indicates that the agitation must be such that the oil and air is not carried down again into the body of the mixture.

Q. 149. And how about the disturbance of the surface?

A. In such a case there should be no disturbance of the surface, except what must be caused by the bursting of air bubbles in it.

Q. 150. Now, have you had constructed an apparatus in accordance with the Kirby drawings?

A. Yes, I had such an apparatus constructed. It was a matter of great difficulties, such as in getting air pipes through the center rotating tube. No pro-

P. 4494, L. 30, after "great" insert "difficulty because in several places *we* found mechanical"

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vision is made there for the proper junction of these different pipes as they pass through the central tube. It leads one to believe that that is a drawing that has never been reproduced on a large scale, or these defects would have been remedied.

Q. 151. That is to say the drawing indicates that it was not a drawing made from an apparatus?

A. No; the drawings could not possibly have been made from an apparatus, or they would not have left these defects which are somewhat serious and gave us a good deal of trouble in reconstructing the apparatus.

Q. 152. But did you make an apparatus in exact accordance with these drawings?

A. I had one made, yes.

Q. 153. And you have that apparatus in court?

A. Yes, it is here in court.

Q. 154. And will you in that apparatus carry out the Kirby process?

A. Yes.

Q. 155. What ore will you use in carrying out the Kirby process?

A. We shall use some of the ore from the Rossland mine.

Q. 156. Is or is not that the particular ore described in the Kirby specification?

A. That is the particular ore; you will find the reference to it on page 1, line 58, and again on page 2, line 16.

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Q. 157. And in carrying out the Kirby process in the Kirby apparatus with the Kirby ore, what oil will you use?

A. A mixture of 95 per cent of kerosene with 5 per cent of semi-solid residuum of petroleum distillation, which happens in this case to be some Roumanian residuum.

Q. 158. And in what proportion to the ore?

A. I have taken the lower limits, 25 per cent. I will mix that up in the upper tank, tank "A," and then afterwards run the streams of the same oil through the pipes in the separating tank.

Q. 159. And that will be how many pounds of oil to the ton of ore?

A. 25 per cent is 500 pounds.

Q. 160. And when you carry out the Kirby minimum proportion of oil, what do you get?

A. You get a layer of hydro carbon liquid floating on the surface of the separating tank, with the air bubbles passing through it, and at the lower surface of the hydrocarbon, just at the junction of the oil and water, you get a certain amount of mineral floating.

Q. 161. MR. SHERIDAN: Where is the Roumanian residuum from, Mr. Higgins; I was not sure I understood you correctly?

A. It is from Roumania.

Q. 162. MR. WILLIAMS: What do you understand to be the part of the specification which authorizes the use of this Roumanian residuum?

P. 4496, L. 17, after " Kirby " insert " process in the Kirby apparatus with the Kirby ore and the Kirby "

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A. On line 23, on the second page it says, "Trinidad Asphalt." I cannot get any of that; most of that stuff seems to be shipped to South America; so I got some of the "semi-solid residuum of petroleum distillation," which is about the same. The reason why I took the Roumanian stuff was because if there was any chance of getting any kind of a froth, that Roumanian stuff is much more likely to give it than the Pennsylvania residues.

Q. 163. Now, I read from the specification, page 3, line 55, "The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer where it is in contact with the water." Please state whether or not that language describes the kind of float that you get in this experiment?

A. Yes, that describes the float exactly. The hydrocarbon contact with the water should not be expected to be absolutely flat; that gets crumpled up more or less, and gives it an irregular shape.

Q. 164. So that down in the interface or just above the interface you find most of the metal, is that right?

A. Yes, in the upper surface of that layer of hydrocarbon I don't think you find any metal at all.

Q. 165. Now, I again read from the specification, page 3, line 37. "The rotating movement of which leads the floating scum of hydrocarbon liquid, air bubbles and concentrates," etc., does that describe the float that you get?

A. Yes, it does. The scum, there, of course, refers

to all three, liquid, bubbles and concentrate, the liquid being the chief constituent.

Q. 166. And when you say hydrocarbon liquid, you mean what?

A. The mixture of kerosene and residuum.

Q. 167. In other words oil?

A. That is what Kirby constantly refers to as solution.

Q. 168. Do you find air bubbles in that float?

A. Oh, yes, air bubbles are there, chiefly at the upper surface of the oil, and quite free from any mineral.

Q. 169. And what happens to those air bubbles as a general rule when they get up there?

A. Well, they generally burst before they get out of the tank.

Q. 170. I read again from the specification, page 2, line 53: "Some of the hydrocarbon coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant." What do you understand to be the significance of that part of the specification?

A. The hydrocarbon coated particles that float without assistance are undoubtedly floated by the buoyancy of the oil. The others that requre assistance, his object is to attach air to them or oil from his oil streams or air streams, and so raise them to the surface.

Q. 171. That is to say, they will not be sufficiently buoyant until they receive that assistance?

A. Yes, that is what he means.

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Q. 172. And when those particles are thus raised to the surface, what happens to them?

A. Well, they settle down in the oil-water interface, and if they do not happen to fall out of that, they eventually find their way out of the tank through the opening, which is much better shown in another specification where he gives the details of the construction of the tank.

Q. 173. Do you mean figures 2 and 3, sheet 2?

A. No, in the apparatus patent. He gives here the detail drawing of the discharge, which you can see very much better. It is much the same in figure 3.

WHEREUPON an adjournment was taken until 2:00 P. M., May 11, 1917.

2 o'clock p. m. Friday, May 11, 1917.

Q. 174. You may refer to the second Kirby patent, No. 838,626, and the drawing thereof which appears at page 758 of the record in the Hyde suit. You might briefly describe what is shown in that drawing, to which you particularly referred.

A. That drawing shows the tank partly broken away so that the discharge opening "a3" is clearly observed. Two dotted lines immediately inside from there, one of which represents the upper edge of the spitzkasten R, and the lower one a portion of that upper edge cut away so that the floating layer of liquid can pass over the lower portion and be retained by the upper portion. That layer that flows on through the opening a3 and is discharged into the centrifugal machine.

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Q. 175. And what is the function of the pipe marked s^1?

A. That brings down wash water, clean water, to wash away the slime which is carried by some of the water which escapes over the edge marked r^1.

Q. 176. Is there a bottom outlet for that little spitzkasten R?

A. Yes, the spitzkasten R is shown in the plan to be divided up into five compartments and there are holes at the bottom of the compartments to discharge the gangue back again into the separating tank.

Q. 177. So that that is a species of washing of the float?

A. Yes.

Q. 178. And the upstanding part marked "r^2" is the part which you say extends upward above the liquid?

A. Yes, that extends upward above the top of the floating layer of hydro-carbon liquid.

Q. 179. Now, turning back to page 740, the drawing, sheet 2 of the process patent, No. 809959 and looking at the Figure 3, do we see there a section of the spitzkasten and the overflow or outlet?

A. Yes, the section there is very much the same.

Q. 180. What is the outlet marked?

A. 32.

Q. 181. And the wash water part, what is that marked?

A. Wash water part is marked 35.

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Q. 182. And the opening at the bottom of the spitzkasten for the slimes to drop through?

A. That is marked 33. The drawing does not show quite so well the difference in the level between the two parts of the spitzkasten, that is the part between 29 and 30, and the part between 29 and the other side of the tank, you might say, 32.

Q. 183. Now, refer to the specifications for a description of the details of this construction.

A. That is given on page 3.

Q. 184. Page 735 of the record?

A. Line 23. "The edge of this box outside of the skimming bar"—That "outside" there refers to the part between 29 and 30—"is submerged sufficiently to allow the floating material to pass over it, while the remaining parts of said edge is raised above the liquid so as to detain everything passing into it," that is the reason. The part 29 in the direction of the discharge opening 32 is raised so high that it retains the layer, what we call the floating scum, and is here defined as being the liquid.

Q. 185. And when he says, in his specification, "above the liquid" what surface does he mean that it extends above?

A. That is extends above the upper surface of the floating layer of hydro-carbon liquid.

Q. 186. And you might read the following part of the specification.

A. "Owing to the agitation within the tank caused

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by the movement of the arms 23, and the rising air bubbles, the water, even near the top, is not clear, but turbid or muddy with slimes or particles of the non-coated minerals which do not settle rapidly enough to get out of the way."

Q. 187. What does he mean by the "non-coated minerals" there?

A. He is referring there to the gangue.

Q. 188. In ~~these~~ this specification~~s~~ is the term "mineral" applied both to the metallic mineral and the gangue?

A. Yes.

Q. 189. And then the next statement of the specification I have heretofore read: "The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water." Then, following that, "The discharge gate, 32, in order to permit these floating particles to pass by must be set low enough to clear them and must therefore allow a portion of the water to pass out with the skimmings, and this muddy water would therefore carry some suspended particles of worthless minerals, which would make the concentrate impure. The settling or concentrating box is designed to prevent or lessen this evil." That refers to the function of the settling box, and the object of it?

A. Yes, including the wash water which comes down through the pipe marked 35.

Q. 190. Now, have all these details been repro-

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duced in the Kirby machine that you are about to use?

A. There is a slight difference in the suspension of the skimming bar as compared with this drawing in figure 2.

Q. 191. And what is that difference?

A. We have that fastened on to the little spitzkasten.

Q. 192. How is it as to position?

A. I think the position is about the same.

Q. 193. That is to say instead of fastening it on to bars extending across the top of the machine, you have fastened it directly to the spitzkasten?

A. Yes.

Q. 194. Does it function the same?

A. Oh, yes, quite.

Q. 195. Now, in this operation in the Kirby machine with the Kirby ore, what are you going to do?

A. I am going to take some of the Rossland ore which has been crushed to 80 mesh.

Q. 196. In crushing it to 80 mesh have you followed the directions that you would take from the patent as of Kirby's day, the day of filing of Kirby's application?

A. I think perhaps I have erred slightly in that; I might have taken 40 mesh or 60 mesh. It is an error in the right direction.

Q. 197. Proceed.

A. That amount of ore, 4000 gms., will be mixed with water, with 1~~5~~4 litres of water.

Q. 198. That is how many gms. or c.c.?

A. 14,000 c.c.

Q. 199. And that is what relation of ore to water, what proportion?

A. Three and a half of water to one of ore.

Q. 200. What are the directions stated in the specifications of Kirby?

A. The specification gives three or five times the amount of water to ore, so that that proportion is within the disclosure of the patent.

Q. 201. What will you add to the ore and water?

A. To that we shall add 60 gms. of sulphuric acid, which is at the proportion of 30 pounds to the ton of ore.

Q. 202. Do you find your authority for that in the Kirby patent?

A. Yes, he says: "The preference of the water for other mineral particles may be regulated by adding some acid or other chemical."

Q. 203. Have you tried it without acid?

A. Yes, I think I have.

Q. 204. And which has given you the best results?

A. The presence of the acid improves the result.

Q. 205. What else will you do?

A. To that mixture we shall add a thousand gms. of kerosene and Roumanian residuum, 95 per cent kerosene, and 5 per cent of residuum. The amount of the oil added will be 25 per cent to the ore.

Q. 206. How will you proceed?

A. After agitating those together in A tank for

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ten minutes, they will be discharged into "B" tank, which is the separating tank, and there they will be treated to streams of oil and air as described by Kirby in his specification.

Q. 207. Those streams of oil and air will flow from whence?

A. They will flow from head tanks through the agitator into small pipes at the bottom of the agitator, which distribute the oil and air.

Q. 208. So that the agitation, as it slowly rotates, will distribute streams of oil and streams of air?

A. Yes, with the object of assisting the concentration of the ore, of the oil coated minerals which have not floated to the surface with their own buoyancy.

Q. 209. Now, will you start the operation? At what speed will you rotate the agitator in the mixing tank?

A. At 192 r.p.m., but this will be reduced to 188 with the load of ore.

Q. 210. And the lower or second vessel, what speed of rotation will you have?

A. 30 r. p. m.

Q. 211. Are you going to use baffles in the mixing vessel?

A. Yes. Without the baffles the oil is not satisfactorily broken into the small bubbles that Kirby directs you to obtain.

Q. 212. What would happen if you have the liquid in the vessel and rotate it as fast as you do without baffles?

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A. You would get a beautiful shower of water over the edges.

Q. 213. It would overflow from the vessel?

A. Yes.

MR. GARRISON: If your honor pleases, each side is, by mutual consent having the record and transcript of the trial printed jointly just as it is transcribed by the stenographers, and we desire to have your honor's permission to have this constitute the record and transcript on appeal.

MR. SHERIDAN: That is satisfactory.

MR. GARRISON: Now, if your honor pleases, we have taken up between ourselves the question of the oral argument, and of the brief thereafter, and we desire to submit to you what will be agreeable to counsel, if it meets your wish.

Our agreement is as follows: As to the oral argument, the plaintiff to open and reply, each side to have seven and one-half hours. Each side to divide its own time as it sees fit among as many counsel as it pleases.

As to the brief, each side to file a main brief on or before the first day of July, 1917, and to have three days extra for the service thereof upon the other side.

Each side to have twenty days for filing a reply brief, the twenty days to run from the time of receipt of service of the main brief; and to have three extra days for the service of such reply brief on the other side.

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May I inquire if that is satisfactory to your honor?

THE COURT: It may be entered in accordance with the court's order and approval.

Q. 214. MR. WILLIAMS: Now, will you add anything that is necessary to complete the description of the operation as you carried it on?

A. The mixture was agitated in the tank A for ten minutes and then discharged to the tank B. The tank A was practically completely discharged in 11 minutes. The operation was then stopped. What was left in tank B should be considered to be only partially treated material and left out of the consideration as far as the results go. The results should be taken as comparing the separated concentrates with the separated tailings, with reference to the oil that was fed into the tank.

Q. 215. What sort of a float did you obtain in the separating vessel or separating tank?

A. In the separating tank there is a thin layer of hydro-carbon with mineral carried chiefly at the oil-water interface. The layer of course was not flat, because of the disturbance caused by the rotation of the agitator and also the passage of the air through the pulp. The stream of the float which came through the pipe into the receptacle separated very clearly into two layers, one of the oil and the other the interface which carries the mineral. In that receptacle of course the interface is a good deal cramped and it rolls itself up into all kinds of funny shapes.

Q. 216. And the concentrate that you have obtained, is that in this vessel?

A. Yes, it is.

Q. 217. And how would you describe that concentrate?

A. The concentrate is separated into two parts, one of which appears to be clean oil at the top with a very few bubbles in it, the under layer being largely water, oil and concentrate.

Q. 218. How many bubbles did you count there, estimating them?

A. I should say there was about twenty small bubbles.

MR. SCOTT: Do you mind if I ask Mr. Higgins where the water is, and where he sees the two layers so plainly?

Q. 219. MR. WILLIAMS: May I ask where the water is, and where you see the two layers so plainly?

A. On top there you see the water,—

Q. 220. MR. SCOTT: On the top the water?

A. On the top the oil. Now as you move it from side to side you can catch a glimpse of that layer underneath.

Q. 221. Of what?

A. That is the water layer, and between the two you get the mineral.

Q. 222. MR. SCOTT: What is on the bottom of the pan?'

A. That is a part of the water layer which is sticking to the pan. There is some gangue in that, and

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there seems to be some mineral also. If we had this put into a bottle it would become perfectly clear that there are two layers in it.

Q. 223: MR. SCOTT: How much oil was there in there, would you estimate, or is there any way of telling?

A. If you would pour this into a large bottle, I think we should be able to see the layers very much better.

Q. 224. Describe it to the court.

A. Having put the concentrate into a bottle, the two layers are very clearly discernable. The crumpling here is due to the compression of the interface of the oil and water. The upper part of the oil layer appears to carry no mineral at all, and underneath that is the water and between the two the mineral.

Q. 225. MR. SCOTT: Point out the mineral.

A. The mineral is seen here in this space.

Q. 226. About an inch deep?

A. Not quite.

Q. 227. Three quarters?

A. Say there is three quarters of an inch there.

Q. 228. You don't mean to say that that three-quarters of an inch is the interface?

A. That is what it is exactly.

Q. 229. The interface is three quarters of an inch thick?

A. The interface has been crumbled up just as I say in that bottle.

Q. 230. There seems to be a division of the oil and mineral and the water below the mineral?

A. The interface of oil and water is crumpled up and the oil is above. The bottle does not give it a chance to spread out. If we had it in a larger vessel it would spread out into a horizontal surface, and still carry the mineral.

Q. 231. Why isn't it crumpled and irregular on this edge if there is such a crumpling; it is a perfectly plane surface, it looks to me, between the oil and the water. I want you to explain how this crumpling and intermingling is, and where it is?

A. There, see; that moves the interface over there and you get a cleaner surface there; there it is quite sharply defined, the demarcation between the two; so that if you put this into a large area, you give that interface a chance to spread out in its normal position.

Q. 232. What holds up the mineral shown here below the oil; isn't this mineral, this dark layer?

A. Yes, but the oil goes down through into that just as much as the water does; exactly as it does in that case where you have got that gold paint or bronze powder suspended in that interface; there you see the interface is crumpled up.

Q. 233. There are films which drop off there, but we have no body of mineral here. You have a body constituting a stratum, and according to you it is all interface. In this specimen of ours there is just an interface with shreds hanging from it, isn't that so, with this bronze stuff.

A. Exactly; but there you have only about enough

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bronze in it to put on the head of a pin, while here we have got a considerable quantity.

Q. 234. This assumes a sharp line between the two, doesn't it?

A. So does this.

Q. 235. MR. WILLIAMS: Now, Mr. Higgins, in this material as you have put it in the bottle, there is on top a deep black layer; what is that deep black layer?

A. That is the oil.

Q. 236. And does that or does it not contain mineral?

A. There are a few bubbles carrying mineral in the oil.

Q. 237. And the lower line of that black oil also appears to be quite well marked, does it not?

A. It does.

Q. 238. Is that the lower line of the oil?

A. That is the lower line of the free oil, and underneath there is the crumpled up interface. That interface of course settles as nearly as it possibly can to a horizontal plane?

Q. 239. And above that crumpled up interface is what?

A. The clear oil. The interface itself carries the mineral, and below the interface, which is very badly crumpled up, some places extending down three quarters of an inch and other places less—below that you have the water which carries a little of the slime gangue.

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Q. 240. The greater part of the mineral is carried between the water and the oil, is that right?

A. Yes, practically the whole of it.

Q. 241. MR. SCOTT: Now, isn't it a fact that you have a dark colored stratum which we might call black, and that is the oil?

A. Yes.

Q. 242. And below that you have a lighter colored body, and the two are separated by a sharp line?

A. Yes.

Q. 243. As viewed from the outside of the bottle, the only place we can see it from?

A. That is so.

Q. 244. Will you point out to me what you mean by a crumpled interface; tell me where I can see it; I cannot see it myself.

A. When the interface is loaded that way with mineral it does not flow so readily, you know; it becomes very much more viscous, and it can be bent and squeezed up and turned over as you see in the bottle with the gold paint, and I think I can show you that very clearly if I take a little of this crumpled up interface out of the separating machine and put a little of it in water and let it spread out.

Q. 245. What is in the bowl?

A. Plain water. I have taken some of that mass out of the separating tank and if we put that in the water, I think I can show you that it will expand and give you a thing which you will recognize more or less as an interface.

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Q. 246. Now, what happens?

A. The oil spreads out. You see that the dark color of the mineral and the interface spread out and here is the oil and there the water.

Q. 247. But you have a mere film of infinitesmal thickness here, haven't you?

A. You see by moving that film you can open the crumpling in that interface. You see where that moved out and spread into a flat surface, which is just what one expects of course.

Q. 248. What moves?

A. Why, you see, I am coaxing it so as to move it out; by coaxing it you can spread it into a plane. You see how it spreads into a plane and crumples.

Q. 249. Is not the crumpling merely the configuration of the floating particles that are floating on the surface there?

A. The floating particles show you the configuration of the crumpling. It is not the floating particles themselves. The floating particles cause the crumpling, but it is not entirely due to that; it is due to the loading of the interface.

Q. 250. Where there are no particles you have just a flat surface of oil?

A. No, you have particles there.

Q. 251. It is not crumpled where the particles are not found?

A. No; those—that is right. I have uncrumpled it by coaxing it out.

Q. 252. MR. WILLIAMS: Can you express that

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crumpling up of the interface in a little different language; is there something hanging down?

A. Yes, it hangs down.

Q. 253. What hangs down?

A. The interface.

Q. 254. And what else, if there is anything else?

A. Well, there is some oil there and some mineral and probably some water all mixed up together.

Q. 255. And what you did in this flat vessel was to give the material a full opportunity to spread, you said?

A. Yes

Q. 256. What has resulted from that?

A. The interface I have uncrumpled in a good many places, and then it spreads out into what one usually expects to see in an interface, a horizontal plane.

Q. 257. That now which you see in looking down at the top of this vessel in which you have spread out the material by uncrumpling the interface, what are the black particles?

A. There are a good many black particles here where it is still crumpled up, and there is the loaded interface with some free oil and some free water, containing the mineral. But the gray color there where it is spread out which we see show that it carries mineral; in fact you can see the sparkle of the mineral.

Q. 258. MR. SCOTT: If I should stick a match in there, would you say that the match was crumpled up?

A. No; I was speaking of an oil-water interface.

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Q. 259. Well, it is an air-water face if I put a match in.

A. Well, yes, it is bent to that extent; of course the interface is crumpled up to that extent.

Q. 260. MR. WILLIAMS: What crumples it?

A. The presence of the match.

Q. 261. In this instance in the stuff you recovered from Kirby, what crumples the interface?

A. The weight of the mineral.

Q. 262. Now, in operating the Kirby apparatus as you have it, did you get the results which Kirby described?

A. Yes, I got the results which Kirby described, that is the floating layer which contained the mineral, chiefly at the junction of the oil and water, with some air bubbles and a few water bubbles.

Q. 263. And how does that float that you obtained compare with the Elmore oil buoyancy float?

A. The greatest difference is in the position of the mineral. In the Elmore buoyancy float the mineral is spread through the oil by reason of the viscosity; in the Kirby result the oil is so thin that it is not able to retain the mineral in its body. The mineral falls down into the junction of the oil and the water.

Q. 264. And, as I understand you, some of it hangs there?

A. Yes, it hangs there.

Q. 265. Now, in the Kirby specification is the mixing ~~table~~ tank ever used for any other purpose than mixing?

A. No.

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Q. 266. In the disclosure of the specification is there any suggestion that the separating tank B is used for any other purpose than separating?

A. Yes, there is. On page 3, line 118, he says the separating tank may be used as a mixing tank.

Q. 267. And how does he describe the operation as being performed, commencing line 121?

A. Why, when it is used as a mixing tank the agitator is agitated rapidly and when it is used as a separating tank the agitat~~ion~~or is revolved slowly. That operation is very unsatisfactory because the small pipes that run down carrying the oil and the ore are very likely to get choked up with some of the sand during the mixing operation.

Q. 268. Have you tried it under such conditions with the oil in the separating tank and getting the oil pipes choked up?

A. Yes. I agitated on one occasion with the charge in the separating tank and got the pipes badly choked up. Of course the air and oil ~~in~~ there wasn't going through then.

Q. 269. Now, in changing from a condition o~~n~~f rotating the agitating mechanism rapidly to rotating it slowly, did you find any suggestion in these specifications that the apparatus is to be stopped and then started again?

A. No, there is no such suggestion; there are mechanisms known to the art in which we could alter the rotation of the parts of the apparatus without actually stopping it, and such things are commonly used.

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Q. 270. Now, then, if you were to carry out that description what would you do?

A. One would have an arrangement of pulleys or a cone pulley for that matter, which would enable one to go directly from one speed to another speed without making a change in the operation, without stopping the agitator. That would not be necessary, and in large scale operations it would be a baneful thing to do. To start the apparatus again, you probably would have to get a gang of men into the tank to dig it out.

Q. 271. Relative to the Froment patent, Italian and British, were you present when Dr. Sadtler performed an operation said to be a carrying out of the disclosure of the Froment specification?

A. Yes, I was.

Q. 272. What have you to say as to the operation that he carried out, as to whether or not it was what was disclosed?

A. In the first place Dr. Sadtler took an ore for this experiment which was not a sulphuretted copper ore, but the Butte & Superior ore, which contains zinc. The directions of the patent are to take a "sulphuretted copper ore with its gangue and a gram of limestone, the whole reduced to a powder". I interpret that as meaning that the limestone and the ore should be equally pulverized. In the experiments that Dr. Sadtler had made the limestone was very sharp and it appeared to have been sifted and the whole of the fine powder removed. It had the appearance of rather fine-

ly granulated sugar. I do not think that was the intention of the invention.

Q. 273. How about the ore that was used?

A. I have already said that he took zinc ore instead of copper ore.

Q. 274. But what was its conditions as to grinding?

A. The zinc ore was very finely ground. Dr. Sadtler then ~~had then~~ added oil as far as I remember— No, two drops of sulphuric acid. Two drops of sulphuric acid were next added. The specification says "a few drops." In my opinion two is hardly a correct interpretation of the word "few". I think it wants more than two. I found that seven were satisfactory for the purpose. That was followed by one cubic centimeter of olive oil. It wasn't possible to see the exact thickness of the layer in that case because the slime from the ore obscured the edge of the surface of the water and the oil.

Q. 275. And having in mind that the evidence in the Hyde case was to the effect that the Froment process was used at the Travesella mines in Italy, where Froment was the engineer, and having in mind also the specifications of the British patent, what have you to say as to Dr. Sadtler's belief that olive oil was the oil which Froment may have referred to?

A. I think that the oil referred to in the Froment patent was the oil that was used by Elmore. That was the oil used in the art at that time. And he refers to this, he says, "This invention is a modification

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of the oil process of ore concentration." At that time there was no other process in use except Elmore, so that his oil was probably the same. At any rate, it embraced the same oil; and his thin layer is in contradistinction to Elmore's thick layer.

Q. 276. And how about the use of heat?

A. The use of heat would be fatal.

Q. 277. In the operation that Dr. Sadtler carried on, is that or is that not in accordance with the Froment specification?

A. No, there is no disclosure on the use of heat in the Froment specification.

Q. 278. In the operation that Dr. Sadtler carried on what sort of concentration of ores was obtained?

A. There was no useful result in the operation. The float at the surface of the water may have carried a little more zinc than the bulk of the material—that is as far as the grade goes. The recovery was very low, I should say certainly less than one-third of the material in the float, and then it was floated in a perfectly useless fashion.

Q. 279. And what have you to say as to the test tube disclosure as a metallurgical operation?

A. A test tube disclosure is not even a laboratory operation of carrying out a metallurgical process, much less a commercial method, so that the specification in my mind discloses nothing of a metallurgical value.

Q. 280. Do you form your judgment on the amount of material recovered in a float, by inspection?

A. Yes, that is the first judgment one makes of it.

Q. 281. And, are you or are you not accustomed to doing that in your experiments, some 20,000 or more in number?

A. Yes, I am accustomed to doing that.

Q. 282. Now, turning to the Froment description. What in this do you find, in the Froment description, as to the preparation of the ore? You may summarize that rather than read ~~them~~.

A. The ore is first crushed and then the slime material is washed away in a spitzkasten. Apparently that slime is rejected and discharged to dumps of some kind.

Q. 283. And then the ore that is used is in what condition?

A. The ore that he uses for his process is deslimed ore.

Q. 284. Dr. Sadtler has referred to some experiments made in behalf of the defendant at the Miami trial which he said represented the Froment description. Were you present when those experiments were made?

A. Yes, I was.

Q. 285. And was the ore deslimed or was it not deslimed?

A. In two cases I am perfectly sure it was not deslimed, and to the best of my belief it was not in the third case. The two cases were repetitions of one experiment.

Q. 286. Have you carried out the disclosure of the Froment process, in the Froment apparatus which is

in evidence in this case, since it was in the Hyde case?

A. Yes, I have tried that many times and as to the results, there is sometimes a little floating material comes up to the surface of the vessel which he calls "the vat with coil". The bubbles bringing up this material usually burst there and leave a thin film which we call skin flotation. Of course with this skin there is a little oil intermingled. The metallurgical result of the process is absolutely worthless.

Q. 287. And in carrying out the description as to the first vessel, the centrifugal mixing vessel, have you ever in any experiment obtained any flotation froth in that first vessel?

A. No, I have not.

Q. 288. And you have repeated the experiment have you, several times?

A. Oh, yes, I have done it a great many times.

Q. 289. When the Froment description was received in the Minerals Separation laboratory what was the condition of the operations there as to the wasting or utilization of slime?

A. Well, the first time I saw that description was some time in 1912. As far as I am aware it had been received by the company some time previous to that.

Q. 290. I am talking now of the evidence in the case which shows that it was received at about 1903.

A. At that time we were using the Cattermole process which was really the first process to successfully concentrate slime material.

Q. 291. Returning to the California Journal of

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Technology, have you studied that article in evidence entitled "Experiments on the Elmore Process of Oil Concentration"?

A. Yes, I have.

Q. 292. What general remarks have you to make as to the particular experiments 4, 5, and 6, under the heading of "Tests, Molybdenite Ore", these being the experiments with 2.1% of oil, 5.3% of oil and 8.9% of oil?

A. These experiments show in the first place such low extraction and such low values in concentrates that they are utterly worthless as metallurgical operations. The first experiment was made with 2.1% of oil and the calculation of the results is that they obtained 3 grams of concentrate, that is about 75% of oil to the concentrate. The next experiment they had twice as much oil there, and refer to the same amount of concentrate.

Q. 293. That is, the proportion of oil to the concentrate was about what?

A. In experiment 4 it was 2 grams to 3 grams; in No. 5 experiment it was 5 grams to 3 grams.

Q. 294. Five grams of what?

A. Oil.

Q. 295. To three grams of concentrate?

A. Yes, three grams of concentrate. That would give a concentrate that would yield a great deal of its oil in centrifugal separation, which could be used over again, and I believe that was the method that they adopted. Of course in the third case, that is experi-

P. 4523, L. 30, after " treatments " insert " they have less oil, and when they have one treatment "

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ment No. 6, they increased the oil to 8.9 and they were able to treat that three times.

Q. 296. And what would be a description of these three operations, as you understand them?

A. You mean the three operations in the one experiment, or the third experiment?

Q. 297. No, I am talking about the three operations of experiment No. 6 in the percolating tubes as described at the beginning of the article. Now, how would they proceed in carrying out this third treatment described under experiment 6?

A. In the first place they would make a primary treatment by putting in 8.9 grams of oil, shaking it up violently and separating—I consider that they would separate that concentrate in the centrifugal machine, getting the oil away and using that over again, and make a re-treatment of the tailing.

Q. 298. And those tailings would be the tailings that had been originally treated with the 8.9 per cent of oil?

A. Yes.

Q. 299. And after they got that concentrate, what would they do, take it off?

A. Take it off and separate it again.

Q. 300. And get some more oil out of it?

A. I think they got some more oil out of it, because the significance is that where there were three treatments, when they have the most oil, and when there are two treatments there does not seem to be enough oil to return to the percolating tube.

Arthur Howard Higgins.

Q. 301. What is your understanding of what happens in these operations, experiments 4, 5 and 6?

A. Well, with that quantity of oil to that quantity of concentrate there was a minimum of 75 per cent of oil. That would make quite a nice thin paste, which ~~he~~ has been described as magma, and that magma would become distended with air bubbles introduced during agitation, and what we would have in the percolati~~on~~ng tube would be the flotation of a magma distended with air bubbles.

Q. 302. How about the salt solution? Is salt a frothing agent, a mineral frothing agent?

A. Salt is not a mineral frothing agent.

Q. 303. Although does it produce a froth?

A. It produces foam in water; I don't know whether that is due to the salt itself or to some impurity in the salt, but one gets it with common salt.

Q. 304. How about the oil, what kind of oil did they use according to the description?

A. The oil they used was a viscous petroleum, a heavy residuum of the consistency of the ordinary cylinder oil, with a specific gravity of about .9.

Q. 305. What kind of oil is that; what is its source and origin?

A. It is one of the constituents of petroleum.

Q. 306. Is petroleum a mineral frothing oil?

A. Usually, no.

Q. 307. When used alone?

A. When used alone. I have found one or two exceptions to that general rule.

Arthur Howard Higgins.

Q. 308. What was the character of the molybdenite ore as far as you gathered from the description and your knowledge?

A. The analysis of the figures showed that the ore contained about 2.3 per cent of molybdenum sulphide or molybdenite. It was crushed to 30 mesh and the gangue minerals were orthoclase and quartz.

Q. 309. What was the character of the mineral?

A. The mineral has a specific gravity of about four and a half, a very brilliant metallic luster and breaks during crushing into thin flakes, which are easily taken up by the oil; much like graphite.

Q. 310. And then this concluding sentence of the conclusion as to the foam effect: "The foam effect is best adapted to light flaky minerals, such as molybdenite." What does that suggest as to the possible usefulness of this foam effect?

A. It suggests that it might be used for the treatment of molybdenite or graphite, but the results that have been obtained are not such as to encourage anybody to proceed in that direction, the results being, as I have already said, metallurgically worthless.

Q 311-A. Is blende a light flaky material?

A. No blende is not.

Q. 311. Is copper sulphide?

A. No.

Q. 312. Or lead sulphide?

A. No, they are not. That sentence could be taken as a warning not to attempt to use those minerals with that foam effect.

Arthur Howard Higgins.

Q. 313. How about the sulphides of gold and silver or the native gold and silver; are they light flakey minerals?

A. No; on the contrary gold is a heavy flakey mineral, and sometimes occurs in nuggets, and the other minerals you mention are not flakey. They do not break into flakes during the crushing operation.

Q. 314. Now, are you prepared to carry out the Cattermole process?

A. Yes, sir.

(RECESS).

Q. 315. Now, Mr. Higgins, will you describe the operation which you are about to perform?

A. Three hundred grams of Butte & Superior ore, received by us in 1913, and crushed to 100 mesh, will be agitated in 1500 c.c. of water at 30° .C., containing 1.4 c.c. of sulphuric acid and 16.6 c.c. of oleic acid; that is five per cent of oil on the ore. The agitation will be at about 850 r. p. m., and I shall keep up the agitation about nine minutes. After that the granules will be separated in an upcast.

Q. 316. What will be the proportion of oil on metalliferous mineral in the ore?

A. About 15 per cent.

Q. 317. You say that this ore that you are using was received in 1913? From whom was it received?

A. I think we got it from the Butte & Superior Copper Company on application during the Hyde case.

Arthur Howard Higgins.

Q. 318. It was supplied for the purpose of investigation during the Hyde case?

A. Yes.

Q. 319. And was obtained from the defendant in the present case?

A. Yes. It might have been 1912 when we got it: I am not absolutely certain of the date.

Q. 320. And is the ore—has any change taken place in the ore in that period?

A. Not that I am aware of.

Q. 321. Has it been carefully kept?

A. It has been carefully preserved, yes. The water which I shall use to make the separation—that, is, the water running through the circuit will contain .25 per cent of sulphuric acid.

Q. 322. And when you make the separation in the upcast, how about the water that flows through the upcast?

A. I just said that is acidified with .25 per cent of sulphuric acid.

(The witness performs the experiment with the Cattermole machine).

Q. 323. THE COURT: Now, what was that for?

A. This is to make the granules, Cattermole granules. We stop it there to show there was no froth of any kind.

Q. 324: MR. WILLIAMS: What was the condition, now, of this vessel when it was stopped, what was the condition; what was the material?

A. The granules and the coarse sand had sunk

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down to the bottom of the vessel, leaving the slimes in suspension. These are the granules.

MR. WILLIAMS: I ask your honor to observe these granules.

Q. 325. THE COURT: What do you suppose was the recovery on that?

A. I think it was a very good recovery. Yes, I think that is a very good recovery. Of course there is some left in the mixer. We haven't cleaned out the whole of the stuff that we fed in. Of course this is only the coarse sand. The fine sand is still in suspension, or floating, as Everson says.

MR. WILLIAMS: The fine sand—is it slime?

A. Slime, yes.

Q. 326. Now, in this operation that you have just conducted, have you anything to add to your description? In the first place, what did you obtain?

A. I obtained some very well defined granules, I suppose about a millimeter, and perhaps a little larger than that, having the appearance almost of caviare, except it is not quite so black. The sands were extremely white in the slimy portion and contained only a very few specks of dark-colored material in the coarser portion.

Q. 327. And was the recovery a good recovery?

A. Yes, the recovery appeared to be very good. And the grade of concentrate also should be high.

Q. 328. Now, why did you use 5% on the ore and about 15% on the metalliferous mineral in carrying out this operation?

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A. In the first place the ore was crushed very much finer than what Cattermole would have to deal with in his time, and he says that the amount of oil you add, depends, among other things, on the fineness of the ore. In the second place, the gangue has a slight tendency to absorb some oil. which is another factor to be taken into consideration, and in the third place I wanted to get nice large granules that everyone could see without doubt were actual granules, so as to make a fine specimen.

Q. 329. Now, there was an experiment on behalf of the defendant in which the oil was in the proportion of 1½% of the ore; did you see that experiment carried on?

A. Yes, I did.

Q. 330. Did that experiment produce granules?

A. No, those were not granules at all; there was possibly some attachment between the coarse mineral and the fine mineral, one might call that an agglomeration, but they were in no sense granules.

Q. 331. And why did the metalliferous mineral sink in the up-cast?

A. The mineral was—the mineral was subjected to centrifugal action in the low speed of the agitator. That is, when they were running it at 300 revolutions per minute, that is, subjected to the centrifugal separation. The tendency there would be to throw the minerals outside of the agitator and draw the air in at the center of the vortex, and so destroy the stuff previously obtained, which was called froth.

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Q. 332. What is the relative specific gravity of the mineral and the sand, about?

A. I think the specific gravity is about four and a half of the mineral, and it is about one and a half of the gangue.

Q. 333. Now, would you regard that operation as a carrying on of the Cattermole process?

A. No, I should not.

Q. 334. Now, in your operation you have 5% of oil on the mineral?

A. Oil on the ore.

Q. 335. Suppose you had diminished the percentage of the oil, how would that affect the operation?

A. The granules would have been smaller. It might have taken a longer time to perform the operation, but I think if I had the two up-casts, in one to take out the fine material and then follow by another agitation, and in another to take out the coarse, I think one could reduce the amount of oil very considerably and still get Cattermole granules.

Q. 336. Well, under the conditions which prevailed in this experiment, the use of a single up-cast, was or was not the proportion of oil that you used a very great proportion for the Cattermole process?

A. I think the result shows that the proportion was an excellent proportion to take for that purpose.

Q. 337. What is the method of deciding in any case the proper proportion for a given ore—proper oil proportion for a given ore for the carryng out of the Cattermole process?

Arthur Howard Higgins.

A. The result is always the criterion.

Q. 338. You determine it by tests?

A. Yes, one usually makes a few tests to see what proportions give the best results. Of course I am not considering now the economics of that proceeding.

Q. 339. But if you were to carry out the Cattermole process you would take everything into consideration and it would be a matter of test. Is that right?

A. Yes, it would.

Q. 340. Can you arrive at the proper proportion for a Cattermole process for a given ore as a matter of mathematics?

A. No, you can not, because he gives a proportion of oil as depending on no less than seven different factors. That is, he does not give the different rates at which these factors vary or the rate the oil varies with these factors, and it is quite impossible to calculate the amount of oil you should use. That must be determined by experiments.

Q. 341. Now, are you ready to carry out the experiments in accordance with the disclosure of the patent in suit?

A. Yes.

Q. 342. And you may state what you propose to do.

A. I propose to take 500 grams of the Butte & Superior ore that we received in March, 1917.

Q. 343. Received from the defendant or the defendant's representative?

A. Yes. To which—and which has been ground

to pass a 65 mesh screen, 2000 c.c. of water at 40° C., 5.8 c.c. of sulphuric acid, 0.55 c.c. of oleic acid.

Q. 344. And that is what per cent of the ore?

A. That is .1% or 2 pounds of oil to the ton of ore. And this should be agitated for about three minutes at about 850 or 900, in the same type of apparatus—

Q. 345. (Interrupting) Revolutions per minute?

A. Yes. In the same type of apparatus as the Cattermole was done in, the only difference being that the vessel is made in two parts so that the top can be slid over the bottom part and so shear off the froth which is obtained.

Q. 346. And what do you call that apparatus?

A. We call that the slide Gabbett.

Q. 347. What was the apparatus that you used in the Cattermole experiment? Was it a Gabbett in which the upper part did not slide off; is that correct?

A. Yes.

Q. 348. This sliding Gabbett, what does it resemble in the fact of the slidability of the upper part?

A. It resembles very much the slide machine in this particular instance.

Q. 349. But what will the agitator be in this Gabbett?

A. The agitator is a cone driven from the bottom of the machine instead of a cone driven from the top of the machine.

MR. WILLIAMS: The experiment is a failure. It is the first time that Mr. Higgins has made a failure.

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The belt was slipping on the machine and he did not get enough agitation.

Q. 350. How long will it take you to fix the machine, Mr. Higgins?

A. Ten or twelve minutes.

Q. 351. Now, what, if any, comment on the testimony that has been given relative to the plant in suit do you desire to make?

A. The chief comment I have to make is about the agitation. The agitation at the time of Cattermole was the most vigorous agitation which was being used in the art. Cattermole took an agitator from another art, and by increasing the speed to a very great extent he introduced into the metallurgical art the high speed agitation.

Q. 352. And what was that apparatus that Cattermole took from another art?

A. The cone mixer or the Gabbett mixer.

Q. 353. And how had that mixer been used before Cattermole used it?

A. It was used in the coal tar industry, to keep the coal tar in the still circulating from the bottom to the top or from the top to the bottom so that the tar did not set in the still and char during the distillation. The Gabbett was also used at slow speed in cyanide work, keeping the cyanide solution and the pulp in solution. There again it was used as a slow speed agitator.

Q. 354. And for the Cattermole process you say it was speeded up?

A. Yes, the speed was very much increased. Al-

though that increase of speed had the effect of introducing a much larger quantity of air into the solution or whatever was being dealt with, that was not any great defect in the Cattermole process, as long as the granules were properly and efficiently made.

Q. 355. So that with the use of the cone Gabbett in the Cattermole process as it was used there was such speed of agitation as to produce the introduction of considerable air into the pulp?

A. Yes, there was.

Q. 356. And in the Cattermole operation what was the effect of that air in the pulp.

A. The effect of the air on the large granules was absolutely none. There was no attachment at all; but where you got badly formed granules, or some of the granules badly broken, you might get some air bubbles sticking to the granules, and it would so be carried upwards in the upcast, generally in suspension, but still making a defect in the process.

Q. 357. So that the air worked against the process.

A. When it worked at all, it worked against the process, yes.

Q. 358. But nevertheless as the record shows, the Cattermole operations were carried out in the Gabbett up to the speed that the Gabbett attained, which was the same speed that was useful in the process of the patent in suit?

A. Yes; we used to run the Cattermole Gabbett at about 900 r. p. m., and that was the same speed with which we first used the process of the patent in suit.

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The patent in suit says in the example that the mixture is warmed and briskly agitated in a cone mixer or the like, as in the processes previously cited, and the processes previously cited are the two Cattermole specifications.

Q. 359. Which are referred to earlier in the specification in the patent in suit?

A. Yes.

Q. 360. As to the apparatus that is shown in the drawing figure 1 of the patent in suit, what is the function of the spitzkasten, by reason of the fact that it is divided into three parts, J-1, J-2 and J-3?

A. The function of that spitzkasten is to divide the tailings into three separate portions. In J-1 we get the coarsest; in J-2 something a little finer and J-3 the finest material.

Q. 361. What would you call that operation in metallurgy?

A. That is a classification of the tailings.

Q. 362. And the function of this spitzkasten is to classify the tailings, is that right?

A. Yes, that was provided for the classification of the tailings. The general class of ore which was treated at that time, particularly zinc ore and copper ore, was roughly thirty and forty mesh crushing, and the instructions here, beginning on page 2, line 102, it says: "If the ore is crushed to 90 mesh to the linear inch, the froth may contain 70 to 80 per cent," that crushing then was considered so fine that it was doubtful whether the profits of the operation would

sustain the cost of that much finer crushing; so that this spitzkasten would take out the coarse stuff and that could be returned to the crusher or dealt with by some other means. But that is not the apparatus that we need now with the fine crushing that is used at the present time.

Q. 363. The function of the spitzkasten as classifiers is utilized by reason of that sort of arrangement in the classifiers—is it merely a matter of settlement?

A. No; there is in each spigot or each point of the boxes, pipes with valves, so that you can supply washing water.

Q. 364. You might read from the description of the patent as to that?

A. On page 2, line 77: "The boxes are all filled with circuit water; the pulp from the vessel A is distributed horizontally from a flat trough, O, through the inlet K^1. The heavy sands and coarser particles of mineral sink into the first box J^1, from which they are led to a shaking table, a convex buddle or the like, to be treated as above described. The middlings or medium sands fall into the box J^2, and if they contain any mineral, may be returned for further treatment by agitation. The up current of the water from the taps N^1 and N^2 prevents the deposition of any slime in these boxes. The fine sands or gangue slimes settle in the last box J^3 from which they are discharged to waste or further treatment."

Q. 365. Now, in the operation of that apparatus, what effect do these up currents have; how strong are they?

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A. Well, those up currents in the boxes J-1 and J-2 would be very moderate flows of water, so that the water in that neck would displace the slime that was coming down through the swan-neck pipe, N-1 and N-2, so that in fact, if there is any upflow of cleaning water in the spitzkasten, the idea is only to remove form the discharge product the actual slimes.

Q. 366. So that as they are shown there, the up currents would not of necessity cause any upward flow of water in the spitzkasten, is that right?

A. They need not.

Q. 367. They would perform their function without doing that work, is that right?

A. Yes, they could be made to perform their function without making any flow of the water.

Q. 368. And this whole arrangement of classifying the gangue was an incident of the coarse crushing of the ore?

A. Yes.

Q. 369. And did the process of the patent in suit have any effect in the art on the matter of crushing the ore?

A. Oh, yes; the art is now chiefly concerned with crushing the ore extremely finely, even up to 100 and 150 mesh, whereas before the introduction of this process the general range of crushing was about 30 mesh as the finest.

WHEREUPON an adjournment was taken until 8:30 P. M. May 11th, 1917.

8:30 p. m. May 11, 1917.

DR. WILLIAM MASON GROSVENOR, being recalled and having been heretofore duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 1. Please, now, explain the moving pictures you are about to exhibit.

(1)

A. "The strong direct attachment of unoiled or de-oiled mineral particles for air bubbles. Four sizes galena:

6—Milligrams
15—Milligrams
20—Milligrams
40—Milligrams.

The experiment shown is carried out in unmodified water with a substantially uncontaminated air bubble. The 6 mg., 15 mg., and 20 mg. particles have previously been oiled, but the excess of oil has been removed by prolonged bubbling of air, until repeated lifting of the particle on the free moving bubbles indicated the reduction of oil to a minute film comparable in thickness with the film of oil actually adsorbed on the surface of the particle. The 40 mg. particle has never been oiled.

We have here shown in one experiment the strong

direct attachment of the air bubble for both unoiled and deoiled mineral particles. The sizes are chosen for the following reasons: The 6 mg. galena particle illustrates the maximum oil lift which, according to my experiments, can be made with the captive bubble manipulated as gently as possible, provided there is actually applied to the surface of the mineral and the bubble an amount of oil materially in excess of that required to give a layer about thirty one-hundred-thousandths of an inch thick over the whole surface of the mineral particle. This thickness of layer would be approximately that produced on an 80 mesh ore containing 15% lead and 18% zinc as sulphides and showing a screen analysis about as follows:

+ 65= 3.5%
+100=27 %
+150=22.5%
+200=10.5%
—200=36.5%

with the weight of the oil in proportion to the mineral at about 8% of the weight of the mineral content. This layer will be shown to be sufficient to cause strong mutual adherence of the mineral particles to one another and will be called hereafter, for brevity, the Cattermole proportion of oil.

The 15 mg. particle is about the maximum weight that can be lifted with the utmost care if the oil layer is considerably reduced in thickness.

The 20 mg. particle illustrates the maximum weight

that can be lifted by a free moving bubble when the thickness of the layer of oil has been reduced to somewhere in the vicinity of one one-hundred-thousandths of an inch, possibly less, and the 40 mg. particle illustrates the maximum attachment of the captive bubble to very thoroughly deoiled or entirely unoiled mineral. All these measurements are made in the absence, as far as possible, of any soluble neral frothing agent.

It will be noted that the bubble is deformed or pulled out to a greater and greater extent by the increasing load placed upon it as each heavier particle is lifted; that there appears to be no fixed angle of contact between the particle and the mineral. In lifting the 40 mg. particle it will be noted that the lift is at first uncertain, and experience has taught me to associate this phenomenon with slight contamination either of the particle or of the bubble. As in this case the particle was entirely fresh and had never been handled, it indicates to me the very slightly contaminated condition of the bubble, possibly due to the previous contact with the other particles or to some film present on the surface of the bubble which had to be distributed in part upon the surface of the particle before lifting would occur. This phenomenon was seen in the lifting of the large aluminum particle before the court on Tuesday. At first the contamination of the aluminum surface was such, even though it had been washed, that it could not be lifted; even after careful rewashing it was necessary to ap-

ply and re-apply the bubble to the surface of the particle before the particle would lift. I believe this to have been due to impurity still remaining on the surface of the particle, because under laboratory conditions of cleanliness I have repeatedly been able to lift the same pieces of aluminum without any delay or hesitation.

Those four galena particles, therefore, are exhibited to give a sort of measure of the forces with which we have to deal under different conditions.

This view is largely magnified and in order that we may observe accurately what happens, the sharp jerks that are necessary to remove the 6 mg. particle, the less vigorous movement required to move the 16 mg. particle, and the still less vigorous movement necessary to separate the 20 mg. particle from the bubble are clearly apparent in the picture, and serve to indicate how a more violent shock, or some sudden movement is practically equivalent to a heavier particle.

(2)

OIL GLOBULE FAILS TO PICK UP EVEN LIGHT METALLIC PARTICLES, AIR BUBBLE PICKS UP SIMILAR PARTICLES MANY TIMES AS HEAVY.

The purpose of this picture is to illustrate the relative weakness of the oil attachment. There is no

question of the selectivity of the oil, or its adsorption on the surface of the mineral producing highly viscous, strong films. But where a larger amount of oil is used than that necessary to produce this minute adsorption layer, we immediately begin to deal with oil in bulk and the high viscosity and original surface tension of the film becomes modified and may quickly become an entirely secondary factor in determining the attachment of mineral to bubble. The oil globules therefore, may have excellent attachment and not necessarily any substantial lifting power. This experiment is shown with both aluminum punchings and with galena. The galena particle weighs 5 mg., the aluminum disc 16.7 mg. and for comparison of the direct air attachment unobstructed by oil there is shown similarly the action of the air bubble on a 30 mg. galena cube and an aluminum punching weighing 54 mgs. The size of the small galena cubes was .87 millimeters and the size of the other galena cube, 1.9 millimeters and calculation shows that the results with aluminum correspond in effective surface tension with the result shown by galena particles. In this case the air bubble is made during the taking of the picture and shows the expressing of the air from the ink dropper underneath the cup shaped glass bubble holder beneath the water. As an illustration of the slight affinity of air for the silicious materials of the gangue, note the slight attachment of the air bubble for the glass dropper when it is withdrawn. The strong attachment and easy

William Mason Grosvenor.

and sure lifting of the 30 mg. galena particle and the 54 mg. aluminum particle are in strong contrast with this lack of attachment to glass. When the aluminum punching is dropped it appears on the bottom as a round object because standing on its edge.

It was noted in the last picture that when the maximum weight is attached to an air bubble, the air bubble necks out to some extent at the point of attachment under the strain of its load. The high surface tension of the air-water surface, finally, closes up this neck and peels it away from the mineral particle. It will be observed that when the oil globule is being made under a bubble holder exactly as the air bubble was made and when the dropper full of oil is withdrawn from the globule there is a long thin necking out of the oil. The drawing out of this neck is clearly distinguished from the air because the far lower surface tension does not choke off the neck. In this case about 14 dynes per centimeter is the tension of the oil-water surface as compared with 73 or 75 dynes per centimeter tension of the unmodified air-water surface. It is therefore not surprising that the small galena particle is not lifted, and that as Prof. Bancroft stated, "the oil necks off because the cohesion of the oil is insufficient." We can not speak of the cohesion of the air and I do not think it clearly expresses the condition to speak of the cohesion of the oil because it is a fluid, even though somewhat more viscous than the air. My way of putting it would be that the oil-water surface was extremely weak as

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compared with the air-water surface and that the strength of attachment of mineral to an oil globule or to an air bubble depends on surface tension. The weak surface tension between oil and water, was ineffective as shown in this picture. The oil breaks off, a portion remains with the particle and a portion with the bubble. One reason why it is difficult if not impossible to assign a precise limit, unless the exact size of the particle, size of the bubble and amount of oil on both is specified, will be apparent as we watch this necking off of the oil. If the particle is large and the amount of oil is small the necking off will tend to be prevented by the fact that the amount of oil does not furnish a long thin neck and that, therefore, the break in the surface must occur while the neck is short and thick. When it is short and thick the circum~~stance~~ference of the neck is much larger than that indicated in the picture. The size of the bubble is somewhat important in relation to the amount of oil because the bubble must be covered with a film of oil and the surface of the particle must be covered with a film of oil before there shall be excess of oil to furnish a short thick, or a long thin, neck of oil. Repeated examination of this necking off phenomenon and the amount of oil necessary to produce or permit it, convinces me that the general range within which this ~~visable~~ visibly occurs for oleic acid, corresponds to about 8.0% of oil as compared with the weight of the mineral and that other oils vary according to the character of the oil in this same general vicinity. It

will be apparent, therefore, that no amount of oil comparable with a film two five-hundred-thousandths of an inch thick is responsible for the change in the behavior which occurs when the layer of oil becomes about one hundred and fifty five-hundred-thousandths. In other words the adsorption film five hundred one-hundred-millionths is far too minute as compared with the layer which is critical or effective in stripping mineral from the bubble. It is only five hundred one-hundred-millionths as compared with thirty thousand one-hundred-millionths or about 1% in thickness of the oil layer which is critical in stripping the mineral from the bubble. The latter can not be regarded as being an adsorption layer.

(3)

AIR BUBBLES DO NOT READILY ATTACH THEMSELVES TO OIL GLOBULES AND HAVE SLIGHT IF ANY LIFTING POWER WHEN ATTACHED.

Again we see the air bubbles being made under the glass bubble holder and note the nearly spherical bubble due to surface tension, like the rubber skin of a balloon, only slightly flattened because of buoyancy against the cup of the bubble holder. We see the bubble lowered into contact with the galena cube weighing 40 mg. and the galena particle being lifted. In examining the successive pictures of the film with a magnifying glass the mineral particle appears to snatch

William Mason Grosvenor.

the surface of the bubble to itself on close approach of the bubble. There is only one picture in which partial contact may be observed even though the pictures succeed each other at a rate of 16 per second. We shall discuss later how wonderfully rapid these movements of bubble films actually are. Contact with the particle is secured by further lowering of bubble holder and the particle is easily raised. Then the oil globule is formed on the particle appearing as a transparent dome about one and one-half times the volume of the particle. The air bubble is formed and brought in contact with this oil globule and there is a remarkable difference noticeable between the readiness of attachment of the air to the oil globule as compared with the instant attachment shown for the galena particle. When attachment is made, however, we can note the subtile change in the appearance of the whole bubble as the oil flashes over it; the upper portion being a very minute film with the lens of oil described by Prof. Bancroft on the bottom of the bubble. As the bubble is raised we shall see the precise phenomena which he described in the necking off of the oil. No one would think of describing this particle of galena and this air bubble as directly attached and, knowing that the unmodified bubble or the modified bubble is easily capable of moving this galena particle, we are forced to believe that it is the presence or the absence of substantially direct attachment which determines an effective lifting or flotation of mineral.

William Mason Grosvenor.

The oil used is spindle oil, viscosity (Engler) 6 minutes, 4~~8~~6 seconds at 20 degrees and specific gravity of the oil, 0.895 and the mineral 7.4. In this case one contact was made between the oil and the bubble before the oil flashed around and entrapped the bubble. The second illustration of the same thing will be shown with the particle already oiled on the bottom of the cell and in this case it will be seen that the bubble is brought in contact with the oil globule three times before attachment of the oil to the bubble is secured. It is clear, therefore, that attachment of air to oil is not as quick and effective as that of air to mineral. It is very clear that with this amount of oil the lack of cohesion (if we prefer to express it that way), or the weak surface tension of the oil, prevents attachment of the air bubble. What we have seen typifies exactly the condition of the mineral particle and an air bubble joined with sufficient oil to permit the mineral to move out away from the inner face of the film into a sufficient quantity of oil to surround the mineral particle and permit the particle to separate from the bubble film proper and be sustained in oil having the properties of oil in bulk.

(4)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL TO PRODUCE ADHESIVENESS.

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(5)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL (COTTON SEED), to PRODUCE ADHESIVENESS.

Since we have seen that there is some amount of oil which will prevent direct attachment of mineral to the bubble, we are called upon to seek some indication of the line of demarcation at which the mineral ceases to become indirectly attached and becomes directly attached to the bubble film. A little thought, a moment's consideration, will convince one that if there is sufficient oil on the mineral to serve as a medium of attachment to another particle of mineral. there should be sufficient oil to serve as a medium of indirect attachment to an air bubble. A minute quantity of the oil will be required to supply the air bubble with its film, but even though the air bubble is thirty times the diameter of the particle and, therefore, possesses one thousand times the surface, the thickness of the film required by the bubble is only ten one-hundred-millionths of an inch, or sufficient to alter the thickness of the layer on the particle by about ten one-hundred-thousandths of an inch in thickness. For this rough comparison it makes no difference that the bubble is spherical and the particle is a cube. If the particle starts with a film about thirty one-hundred-thousandths thick (Cattermole proportions), it will still have left after coat-

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ing the bubble, enough oil to furnish itself with a layer twenty one-hundred-thousandths thick or twenty thousand one-hundred-millionths or two thousand times as thick as the oil film on the surface of the bubble. So that it is important to observe whether under these conditions the drawing of the oil together (i. e., the reduction of the film on the particle from the remaining twenty one-hundred-thousandths to the adsorption layer) will furnish enough excess oil with that held to the upper surface of the mineral by adsorption and that on the bubble to produce an intermediate layer of oil between the mineral and the bubble, capable of necking off and producing indirect weak attachment.

Again we shall compare the unoiled aluminum disc with the two oiled aluminum particles; the former weighing 50 mg. and each of the latter weighing 25 mg. The two latter, however, had been oiled with cottonseed oil, specific gravity .92 and weighing .26 mg., about nine-tenths per cent of the weight of the aluminum particle, and producing a layer of oil about thirty one-hundred-thousandths of an inch thick on the surface of the aluminum. This layer on the surface of a material ground to eighty mesh will require between 4% and 8% of oil on the mineral by weight. It is seen that the air bubble peels off from the surface of the particle after substantial attachment and careful examination of the pictures highly magnified, shows that there is distinctly something between the air bubble and the mineral particle. This amount

of oil is sufficient to produce adhesiveness as we will show by the ability to pick up one oiled particle with the other and the excellent degree of adhesiveness that results.

(6)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL (OLEIC ACID) TO PRODUCE ADHESIVENESS.

Identical operations are shown with oleic acid. In both cases examination of the picture highly magnified permits us to see the taking of oil from the general surface of the particle as if by suction on the face of either the bubble or the other mineral particle, as the case may be. When adhesiveness is shown it is only during this contact and drawing oil over the particle that there is sufficient oil to be visible and when the particles are separated the oil disappears from sight.

(7)

THE UNLIMITED CARRYING POWER OF AIR BUBBLES AS COMPARED WITH OIL.

AIR BUBBLES IN WATER LIFT PIECES OF ALUMINUM ONE INCH IN DIAMETER, .05 INCH THICK.

The dual object of this experiment is to show first how great the carrying power of sufficiently large

air bubbles may be made if their load is suitably designed. The same aluminum piece is shown as was used on the 8th before the court. It is slightly over one inch in diameter, .05 inch thick and weighs about one and seven-eighths grams; it is just about the size of a twenty-five cent piece, but of course the aluminum is much lighter. Having exhibited the aluminum disc, the picture shows it being deposited on supports along the edge of the cell to prevent its sticking to the bottom of the cell. The large air bubble is then shown to descend upon the disc and a marked difference in the quick, complete attachment will be observed as compared with my first effort to lift the disc in court. This will serve to emphasize the necessity of cleanliness and the advantages of making photographic records of what takes place under laboratory conditions, which can be accurately governed in the respect of cleanliness or precise degree of contamination.

Attention is called in this case to the firmness with which the aluminum disc adheres to the bottom of the bubble, swaying from one side to the other and bumping against the side of the bubble holder. The question will probably be asked "why are results that require such extreme cleanliness or such precise degree of oiling as to make necessary the greatest laboratory precaution, of any interest to mill operations?" But this question answers itself instantly when we consider the enormous tonnage of material being treated and the relatively infinitesimal amount of opportunity

which the material has for becoming contaminated. It is a matter of common experience among technical men that far more precise results can frequently be obtained in handling tons than it is possible to secure in the laboratory handling grams. In manufacturing sulphuric acid for instance, the regular daily product of a number of factories with which I am acquainted, contains less than .0005% of arsenic, although there are considerable quantities of arsenic in the ore from which the acid is made. So small is the amount left by our regular commercial methods that new and special methods of analysis starting with a two pound sample of material had to be devised before we could determine the amount of arsenic which was present. Another point in this connection is that it takes days and sometimes weeks of continuous operation after starting up a new plant to wash out the systems and attain standard conditions. after which hundreds of tons of material going through in a day keep it washed out with a degree of completeness that no laboratory purification can approach. When, however, we begin to juggle with the plant, introducing impurities one day and omitting them the next, plant tests, just for this reason, frequently become less reliable than laboratory tests. It may take a week to overcome the advantage or disadvantage of one day's unusual operation, and my careful study of chemical manufacturing would lead me to expect that commercial flotation plants such as I have seen, when once contaminated by soluble frothing agent, might

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require weeks of running without frothing agent before the benefit of that soluble frothing agent could be eliminated.

(8)

SAME ALUMINUM PIECE SUSPENDED BY A FINE THREAD LOWERED THROUGH WATER TO SHOW PLIABILITY OF THREAD.

In order to pass the same aluminum piece back and forth through the oil-water interface, as we propose to do next, it will have to be suspended on threads and to satisfy ourselves that these threads are not rigid, we lower the aluminum piece through the water and show the pliability of the threads and observe the way in which they sag or float freely of their own buoyancy suspended in the water.

(9)

SAME ALUMINUM PIECE LOWERED THROUH OIL LAYER ON WATER SHOWING ABSENCE OF OIL CARRYING POWER.

While this shows the inability of the oil-water interface to support the aluminum piece as did the air bubble, it is not by any means as conclusive as other experiments that are shown. The lesson of this picture is the adherence of oil and the enlarged necking off of the oil under any sufficient strain. This phenomenon is repeatedly seen elsewhere on a much

smaller scale but can here be observed with an enlargement and perfection of detail which can nowhere else be seen.

We see the disc descend through the interface between the upper layer of spindle oil which looks very dark because of its yellowness and optical opacity. As it meets the interface between the oil above and the water below, we have a fine opportunity to observe the different oil neck effects. As long as the disc is very close (relative to its diameter) to this interface, and the walls of the neck are straight, the circumference of the neck is practically the same as the entire line of attachment all around the disc. The weak surface tension of the oil-water interface, therefore, still has the whole circumference of the disc as its operating line across which it may exercise its lifting power.

Imagine now that we are looking at an enormously magnified picture and a minute mineral particle attached to a layer of oil around the bubble; imagine that the bubble had changed its direction with the swirl of the current produced by agitation in the pulp. In consequence of this the inertia of the particle would make it strain at the oil-water interface with its own tendency to continue moving in a straight line and not swing off on a curve. Imagine sufficient oil to permit the disc (or magnified particle) to drag out this interface. This allows the surface tension which is acting around as well as along.

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the neck of oil to counteract it (to decrease the diameter of this neck) and consequently decrease the circumference along which the lifting or sustaining force of surface tension can be operative. Since this contraction starts it is cumulative in effect. We have, therefore, vividly shown in this picture the reason for the somewhat sharp limit concerning which Mr. Scott inquired on cross examination Wednesday morning It will be instantly seen that just as soon as there is enough oil to permit a particle to swing away and drag with it the oil-water interface, separating it from the oil-air interface and producing a neck of oil in bulk, that such a neck immediately tends to automatically reduce its own strength by constricting its diameter, thinning down to a point where its low surface tension can be exercised over the circumference which rapidly becomes negligible in strength. The lowering of this aluminum disc therefore makes clear in a way that nothing else in these pictures can do, the absence of oil carrying power and the reason for its absence, The billowing of the oil layer at the surface between the oil and water, with its slow movement, indicates the lack of strong surface tension to quickly restore a straight surface. This is also shown by the way the oil is carried down into the water and then the water is carried up into the oil as the disc passes back and forth through the interface. It seems to me we need no better explanation of Prof. Taggart's interesting experiment in which the

water disc dropped down from the bubble through a layer of oil. There is no reason for assuming very high viscosity of the interfacial film, particularly in view of the low viscosity of the interfacial film which was shown with his magnetic spider on the surface of water contaminated with oil alone. A better and more rational explanation why the discs are slow to return to spherical or globular form is a greatly reduced surface tension between the oil and the water and the great inertia of the water enclosed by this film as compared with the air or gas inside of the water bubble films and with which we unconsciously compare these little discs of oil.

(10)

WHEN AIR BUBBLES LIFTING METALLIC PARTICLES MEET THINNEST POSSIBLE OIL LAYER, THEY DROP THE PARTICLES.

Galena Particle 29 mg.	Small Galena Particles	Aluminum Particle 54 mg.

This same insecurity of the oil attachment, or support, for mineral particles entrapped within the oil is observed when bubbles carrying mineral particles are raised to the surface of water that is covered with thin film of oil. It may be said (and has been) that this showed nothing, because the bubbles burst when they met the surface and naturally could not hold the

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particle. In merely viewing this experiment as pictures rapidly projected on the screen for the sake of continuity, this may seem to be so because we can not accurately observe both bubble and particle at the same time. The camera has no such limitations. Any one who will take these pictures and examine them one by one with a magnifying glass will see certain evidence that in at least two cases the particle has completely left the bubble, and slid down on the oil-water interface before the bubble, now modified by its passage through the oil, has had time to burst. I know this is the case in two instances and it appears to be the case in all. This will be discussed in detail for each bubble as it is described ascending through the surface, and is excellent proof of the enormous superiority of photographic observations over mere ocular observations of an experiment. One picture succeeds another, one-sixteenth of a second apart, leaving no doubt as to what occurs or the way of its occurrence.

There is an enormous amount of detailed information as to just what happens, and which happens first, to be gained by the painstaking examination of this series of photographs at critical points with a magnifying glass of about 7 power. An ordinary reading glass is very convenient, but the Hasting Triplet 7X reveals, when applied to these pictures, a wonderful amount that would otherwise escape the eye.

The oil used was spindle oil in the thinnest possible layer that I could maintain on the surface of the water

in the cell. This being a layer and not a film, was of necessity thick enough to be visible, and therefore thick enough to evenly cover the surface by the enlargement of lenses, covering the droplets, in other words, a few hundredths of an inch thick.

The loads used for the bubbles were respectively a galena particle weighing 28 mg., about one-half as much as the air bubble would carry. In another case (the middle one) a number of small galena particles about 40 mesh, were used in the third case a single aluminum punching weighing 54 mg. (about one half what the air bubble would carry). A yellowish mineral oil of medium viscosity was chosen (the yellowishness to enable us to distinguish the oil from the water in the photographing) an oil of medium viscosity was used in order that the surface tension phenomenon could be seen without being too long delayed by great viscosity of the oil. It should be remembered that viscosity does not imply rigidity and that, therefore, the most minute forces will ultimately produce the same movement, if restrained only by viscosity, as the large forces would produce in a short time. Here again I wish to point out the distinction between the stabilizing of a bubble film by the introduction of viscous material which retards its breaking, as distinguished from the stabilizing of a bubble film by the presence of solid material from which the liquid may be generally removed and leave the bubble structure permanently outlined in the remaining solid material. The latter is not viscosity and for want of a scientific term to

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apply to the phenomena which, so far as I am aware, had never been produced and requires description, such a bubble was called an armor-plated bubble. I have seen those bubbles after drying out remain for months. In fact, in one instance I examined a specimen of this dry froth in New York a year after it was removed from one of the beams in the Miami plant, put in a pill box and taken back to the laboratory without any special care. The way in which the mineral particles were interlocked and fitted into an arch, like the dome of a cathedral, and apparently cemented together into a permanent structure like soft pumice stone, was very impressive.

The floating film of oil in the picture appears to be much thicker than it really is because the surface of the water curves against the side of the vessel. Its actual thinness can be observed where it surrounds the stem of the bubble holder after they have been pushed down through it. It is interesting in this picture to see the effect of a quantity of oil sufficient to produce a thin layer on the surface and observe in what manner it would be fatal to air bubble flotation. One by one, the bubble holders are slowly raised to carry the bubbles through the oil layer. We see the galena particle raised to the surface, touch the oil layer and become invisible owing to the rapid movement of its fall, just one picture before the bubble is destroyed. This would not be wholly conclusive if we did not see other experiments and if we had not seen on the afternoon of the 8th, various kinds of mineral

particles stripped from the bubble at the oil-water interface when the upper oil layer was so deep that the bubble had no opportunity to burst. In the next case of small mineral particles we can clearly see in examining the films that a portion of the load had completely separated from the bubble to hang in the oil film before the bubble burst and in the third case the aluminum particle may be seen in three successive stages of sliding down under the surface of the oil layer while the bubble is still in perfect condition. This illustrates the relative precision of observation of the moving picture camera as compared with even the trained observations of an expert like Professor Bancroft who testified that the bubbles burst before the particles drop. Another advantage is the permanently accurate record which these pictures give us. In Wilmington I stated with regard to the galena particle, what was my observation from seeing the pictures on the screen, page 1666, line 20, printed Appeal Record, that the galena particle was left with the oil for about one fourth of a second after the bubble passed through the surface. According to my experience it was entirely immaterial whether the bubble burst first or afterwards. Dr. Bancroft raised the question and I find a precise record of just what occurred by which I can correct his mistaken impression and my own uncertainty.

Likewise, in the case of fine particles, examination of the individual pictures shows that a few of them drop too quickly to be seen except by a minute change

in the pile of particles on the floor of the cell. Some of the others are shown to have settled down the oil slide before the bubble burst. Presumably those in the middle do not decide which way to slide off. After the bubble breaks they also move off slowly, seeking the lowest point on the oil film and gathering together in a clot in which they hang for a few seconds.

During this temporary suspension of the fine galena particles and while they are moving over one another within the oil film and concentrating their load at a point, let us observe the aluminum particle slide down to the lowest point on the oil film quickly draw the oil-water surface down into an oil neck and continue its fall almost without interruption to the bottom of the cell.

Here again individual examination of the pictures shows three or four successive stages of the slide down the oil film before the bubble bursts. Look quickly now to the point where the small galena particles were suspended. We see them gather themselves together drawing the oil-water surface further and further down until the critical condition is reached when the surface rapidly yields and the mineral particles (unattached to the air at the surface. separated from this air by a layer of oil) drag away the weak oil-water surface, and the mixed oil and mineral is dumped on the bottom in a sort of reverse waterspout. This shows us just how the oil layer becomes overloaded. It is what was described as overloading or breaking down of the Elmore bulk oil process. It shows exactly what happens in all

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its stages and helps us to understand the weakness and unreliability of oil air water emulsion whenever the amount of oil is sufficient to prevent direct attachment of the mineral to the bubble.

(11)

MINUTE EXCESS OF OILY MINERAL FROTHING AGENT CAUSES AIR BUBBLES TO DROP METALLIC PARTICLE.

Galena Particle	Aluminum Particle

3-10 milligrams of oil applied outside bubble.

Galena Particle	Aluminum Particle

This experiment shows the effect of an oil globule meeting a loaded air bubble carrying a particle weighing 25 mg. (about one half of the maximum lift) suspended on the air bubble, the aluminum punching weighing 54 mg. is suspended to the air bubble on the other side of the cell. A minute excess of oily frothing agent in the form of a globule is to be brought in contact with each bubble. We shall observe the small curved capillary of glass containing oleic acid approaching the bubble. The trembling of the hand which carries the oiling capillary is clearly seen. We shall watch for the flash or change of complexion in the bubble when the oil actually makes contact with it, as would a small globule of oil stirring around in the mass of the ore pulp and meeting a loaded air bubble.

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This flash indicates the spreading of the m~~n~~onomolecular film and forming of the maximum stable film around the air bubble. Examining the pictures one by one the delay between the first flash and the movement of the oil globule from the point at which it was deposited, may be clearly seen and in my opinion represents the appreciable time required for the monomolecular flash of oil film six one hundredth millionths of an inch thick to gradually increase its thickness up to ten-one hundredths of an inch. When it becomes stable against the little oil globule and the oil globule becomes free to move about ~~above~~ over the film, we shall then see the globule slide down the side of the bubble (as Dr. Bancroft stated under the influence of gravity). In my opinion this indicates the effect of shifting of the film rather than gravity. It shows to a large extent the taking up by the film between the mineral and the air, of whatever excess oil there is on the bubble surface. With no mineral attached to the bubble, I have many times seen the oil globule linger where it was originally put, or slowly rise along the face of the bubble. I consider this film of oil on the inside of the bubble to act something like a pipe. It has a thickness of ten one hundred millionths of an inch and is stable because of attraction~~s~~ between its own molecules which prevents their separating or taking any excess oil from globules or lenses. Suppose we regard the globule of oil as a large soap bubble and the film as a very small soap bubble connected by a pipe to the large one. The

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high surface tension of the small bubble will make it shrink together until its walls touch and the air which it contains will be forced into and increase the size of the large one. In this case the walls of the small bubble may be considered to be the two absorption films on each side of the oil layer and when they have taken enough oil to complete them, they have a mutual attraction for one another which keeps the oil forced back into the relatively large globule having lower surface tension because of its relatively greater size. If we now hang a weight on one side of our smaller soap bubbles and thereby overcome its greater surface tension, the fluid (air) which fills the big soap bubble will be drawn through the connecting pipe into the small one, because now the surface tension of the big bubble is not overcome and may be regarded as being assisted by the suction produced when the weight is hung on the small bubble. Similarly the mineral particle hanging in this double film tends to drag the outer film or absorption layer away from the inner, and can not do so unless there is an excess of oil to slide in (as oil in bulk between the two films of ~~the~~ oil in the film) to permit the two adsorption films on each side of the oil layer to be separated by oil. There is, however, an excess of oil in the globule attached to the side of the bubble and this excess turns into a film as fast as the dragging away on the mineral particle separates the two interfaces of the film in which it is hanging. The mechanism of this separation is probably in, part, a slight flow of oil in bulk between the two a~~b~~dsorption

layers, but is chiefly the dragging of the film itself toward the place on which the particle is pulling. This serves to thicken ~~of~~ the film at that point into a layer by converting the two adsorption films drawn to this point into bulk oil between ~~the~~ thin films as fast as the globule is capable of converting itself into additional film. I have carried this experiment out many times. Always the globule seems to throw off the film in both directions above and below itself and, as the film on the under side is taken away and converted into bulk oil between the particle and the air, the globule is drawn downward until what is left of it joins this mass of bulk oil. If the globule is extremely small the particle does not let go until the globule reaches the edge of the area under tension. If the globule is large or if we slowly feed oil to the side of the bubble from the capillary, there is no such phenomenon and the bottom film appears to thicken into a layer as the particle drops off. In this case we shall see the globule move down the bubble, see the mineral dropping away from one side (approached by the globule) and see it finally let go of the bubble. The amount of oleic acid used was three tenths of a milligram or about 1% of the weight of the particle. The trembling of the hand makes it difficult to be sure of the size of the globule that is added to the bubble or even that only one globule has been added. The inestimable value of the photographic record every one sixteenth of a second is made clear on examining the pictures with a 7 X magnification. We can even measure with reasonable

accuracy the relative size of the particle and the globule and estimate from the size microscopically measured and from the specific gravities the figures given above within about 10%.

Similar phenomena are observable with the aluminum particle. In this case the particle appears to take up its oil through the film, as it is practically ready to drop off during the fraction of a second that the dropper is seen in actual contact with the bubble. The sharp outline of both aluminum and galena particles after they have come to rest on the bottom are the best evidence how little oil was required to strip them from the bubble. The accidental shaking of the aluminum particle by knocking the holder with the capillary is as fine an illustration of direct attachment, as the whole picture is of indirect attachment.

Thus we see how oil acts as a robber of air bubbles, slips in between them and the metal particles and destroys the powerful direct attachment.

(12)

AIR WILL NOT ATTACH TO MINERAL ENVELOPED IN OIL.

Finely ground mineral particles less than 200 mesh (.0029″ .005 mg.) are touched with air bubbles in pine oil, no lifting whatever.

We must, however, convince ourselves that air can have no attachment whatever for mineral enveloped in tangible quantities of oil, ~~upon~~ before this interpretation of

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detachment shall be quite conclusive. To do this beyond question, we must satisfy ourselves that this is also true of fine dust. So we shall see in this picture minus 200 mesh galena containing dust of most minute size placed on the bottom of the cell filled with pine oil. The same experiment has been carried out with other oils and other mineral giving exactly the same results. The fineness of the dust is illustrated by the smoky appearance of the trail left by the forceps as they are entered into or withdrawn from the oil. We shall see the captive air bubble brought down repeatedly and firmly into as close a contact with this pile of dust as the surface films of oil on the dust and the bubble will permit. In doing this we exactly duplicate the condition of oiled mineral held in oil on the surface of an air bubble, when excess oil permits thickening of the film into a layer. The bubble is withdrawn without the faintest trace of attached mineral.

(13)

MAGNIFIED VIEW OF CLEAN AIR BUBBLE IN PINE OIL NO MINERAL ATTACHED.

To satisfy myself of the absence of such attached mineral, no matter how fine, I have repeatedly examined the bubble highly magnified, and show here a photograph of the illuminated under-surface of exactly the same bubble which you saw in the previous picture, taken immediately after it was withdrawn from the mineral. There could be nothing more conclusive than

this test, of the failure of mineral to remain in contact with the air bubble film, when the amount of oil permits the outer film at the oil-water surface to become so far removed from the bubble as to permit the mineral to stay at the oil-water interface and go away from the oil-air interface.

(14)

DE-OILING OF THE GALENA PARTICLES—KEROSENE RAPIDLY REMOVED. THREE SIZES SHOWN IN PINE OIL AND WATER.

6mg. 16mg. 20mg.

We saw in court on the 8th with what difficulty excess of oleic acid was removed from galena by air bubbles. We shall here see one of the peculiarities of kerosene which may have led to its selection as the oil with which to attempt flotation at high ratio of oil to minerals. We shall see clearly why excess of kerosene oil on the mineral is less harmful than other oils, because the excess is more readily eliminated from direct contact with the bubbles actually lifting the mineral, so that it may become a harmless excess instead of remaining a harmful one. For the experiment with oleic acid in court the 16 mg. particles was chosen. 20 mg. have been repeatedly de-oiled from oleic acid and lifted, but it takes more time. Here we shall see all three particles soaked with kerosene and having a considerable excess, placed on the cloth false bottom of the same cell and photographed while the air bub-

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bles were passing over them just as we passed the air bubbles over the 16 mg. particle before the court. It is really remarkable to note the rapidity, amounting almost to suddenness, with which the first few bubbles snatch away the excess of kerosene. Kerosene behaves more like a liquid mineral than like a flotation oil both in its attachment to air and with respect to its inertness as a frothing agent. It is also peculiar in the high surface tension of its interface with water. Consequently, it requires a relatively large amount of kerosene or other mineral oil to bring about the dropping of mineral from the air bubble and it is possible to overload the process with a greater excess of kerosene than other oils, before this excess ceases to be merely useless and becomes positively harmful.

The relative effect of weight of particle is also here observed. It will be observed that 6 mgs. quickly become sufficiently clean to lift, that it takes more time and many more bubbles to lift the 16 mg. and requires still more time and far more bubbles to clean up the 20 mg. The experiment was carried out in water modified with 3½% of pine oil and the smaller bubbles produced in modified water can be clearly seen in comparing this picture with others I have made using only insoluble frothing oils. This difference is beautifully illustrated by the 20 mg. particle. He requires two and sometimes even three bubbles in pine oil water before he will lift whereas with oleic acid he takes but one larger bubble.

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(15-16-17-18-19)

MAGNIFIED VIEW OF DE-OILING 6 MG. PARTICLE FROM KEROSENE. THE RAPID REMOVAL OF OIL IS CLEARLY APPARENT, AFTER WHICH THE PARTICLE LIFTS WITH THE SECOND OR THIRD FREE AIR BUBBLE.

The magnified views were made immediately after the view just shown in the cell and supplied with oil by a dropper as was done before the court on the 8th inst. This shows another interesting difference between kerosene and some other oils. The kerosene does not seem to spread its film over the mineral particle as readily. We saw in court how the oleic acid placed on one side of the particle affected all sides of the particle and continued to do so for hours. The kerosene, though it attaches quite readily to the mineral, does not spread. This is probably due to the fact that water-kerosene has a much higher surface tension than water-oleic (or water-olive, or almost any other water-oil surface), and this higher water-oil surface tension holds it from spreading. So, these particles, having been once deoiled and reoiled under the water in the cell, are shown to be far more quickly cleaned up by the air bubbles than at first. This picture shows clearly the cause of something that puzzled me for a long time. When a particle has once been deoiled by air and carried to the surface by the bubble I thought it should continue to behave that way.

P. 4570, L. 10, after " the " insert "same cell and liquid. The particles were put back in the "

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It was not till such highly magnified pictures were taken that I found the particles falling to the bottom with easily visible quantities of oil on them picked up at the oily surface and brought down. Another peculiarity of kerosene can be seen comparing the magnified pictures of this kerosene with the oleic acid pictures of the same experiment. Owing to the high oil-water surface tension of the kerosene, more oil can be present at the junction between the bubble and mineral, without substantially interfering with attachment. In other words kerosene is peculiarily adapted to be present in considerable useless excess before becoming a harmful excess. Better results are obtained without the useless excess but it is not quickly injurious to attachment. This is seen in the pictures in one case when the bubble catches up a particle that still has an amount of kerosene that is visible when so largely magnifiied.

Nothing could be more conclusive of the vital and critical effect of necking off of oil, as the cause of dropping mineral in air froth flotation, than this correlation of effects actually obtained with those relative physical properties that common sense tells us should have such an effect.

(20)

AGITATION OF WATER UNMODIFIED BY A MINERAL FROTHING AGENT PRODUCE AIR BUBBLES WHICH COALESCE, RISE AND BURST. MINERAL FROTHING AGENTS PRODUCE SMALL AND PERSISTENT AIR BUBBLES.

"UNMODIFIED WATER".

Having seen the effect of oil as a robber of minerals from the air bubbles, we shall endeavor to get some insight into the complex phenomena which the process of air bubble flotation exhibits and which are permitted to stand clearly forth from obscurity only by the elimination of oil or by its reduction to the vanishing point so far as our senses and its effects of adher~~ane,~~ence etc., are concerned.

First we shall see the result of making air bubbles in pure or unmodified water and how instantaneously, when the agitation is stopped, the powerful surface tension films of the bubbles and masses of air draw them together, and they rise almost instantly to the surface.

The action of the air bubbles in unmodified water is very striking when the individual pictures are examined, particularly the magnifiied view, but this view gives us an exceedingly good impression of how great the forces must be, and how rapid their action, when all of that air is forced out of the water in such a brief space of time.

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MAGNIFIED VIEW OF UNMODIFIED WATER.

Then we shall observe a magnified view of that action. We shall see what happens to these air bubbles. We shall see them rising at a rate reduced to about one-tenth of their true magnified rate of movement, because our pictures were taken at 120 per second, and we now observe them at about 12 per second. We shall note that even thus reduced the apparent velocity of their rise is great and likewise that, whenever two bubbles approach each other closely enough, there is a flash too quick for the eye to follow, even though we are now seeing it move only one-tenth as rapidly as actually occurred. After the flash there is but one bubble where formerly there were two. Coalescence has taken place with the swiftness and violence of an explosion.

I may say these pictures are all illuminated from behind, and that is why the bubbles look black. The appearance of hollowness is due to the reflection inside of the bubbles themselves (making a sort of light spot) in addition to which there are equatorial parts of bubbles, which are nearly parallel, so that the light goes through without serious distortion. The spark which was used in taking the pictures was located back of the cell, and the light was thrown through an optically clear passage, forming part of the circuit in the cell where these bubbles might pass up between the illuminating surface and the observing opening.

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The pictures are running now something like a tenth of the speed ~~probably~~ at which they were taken, and it gives some idea of the riot that was actually going on in the bubbles. The currents in many parts of these pictures were moving downward at times, when the bubbles were trying to move upward, and we get a compromise movement. In some cases the larger bubbles tend to fall.

While the coalescence appears in the pictures to be fairly slow, it must be remembered that this is an ocular effect. The eye carries over, from the rate of approach of the bubbles, the impression that they coalesce at the same speed. The proof that this coalescence is enormously more rapid than the approach, is that we find a number of successive pictures, showing the approach, but never (so far have I been able to find) two pictures showing actual coalescence going on, and that makes the maximum period of coalescence 1/120 of a second. The actual time of coalescence must be far less than 1/120 of a second. How very much less it really is we can conjecture from an occasional picture that happens to be taken in the actual instant of coalescence. Such pictures, although the duration of the actual spark of illumination was less than 1/25,000 of a second, were not instantaneous enough to make the photograph clear. Careful study of these pictures, one by one, under the magnifying glass, shows the flow lines that always appear in ordinary photographs taken of quickly moving objects. When we consider that the ordinary photograph is

P. 4574, L. 9, after " tend " insert " to rise and the small bubbles tend "

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taken in about 1/~~2~~35,000 of a second, and that these photographs are taken in something like 1/1000 of that time, the inconceivable swiftness with which the surface tension snaps two bubbles into one is dimly appreciated and the violent shock that would result to metallic particles suspended on the bubbles can well be understood. Judging from the flow lines of the pictures that we have, the period must be in the neighborhood of 1/16,000 of a second, as the actual coalescence time. It is difficult to believe that such minute action can be violent until we study the pictures in detail and see its amazing swiftness, like the flash of an electric spark. Among these pictures of coalescence, we find occasional pictures where three bubbles come very close together at the same time; then two of these coalesce and almost invariably the third (perhaps 1/100,000 of a second too late for its appointment) is thrown entirely out of the sphere of attraction by the explosive violence of the coalescence between the other two.

I do not think we can see that clearly in the films as they are run but when the pictures are examined under a magnifying glass, it can be seen very clearly in many cases.

A further confirmation of the extreme suddenness of this explosive coalescence may be obtained from the fact that only in about one case in a hundred where coalescence has been observed and studied do we happen to get a picture in the actual process of joining. The interval between pictures is 1/120 of a second.

The duration of each picture is probably about 1/36,000 of a second, and the law of averages indicates that the actual duration of these coalescences cannot be much more than about 1/12,000 of a second.

The mineral particles suspended on the air bubbles in pure water would have about as much chance of surviving their attachment as a beetle hanging on a stick of exploding dynamite. At last one can appreciate what is radically wrong with pure water as a medium of mineral flotation.

(22)

WATER MODIFIED BY OLEIC ACID.

We shall now see clearly that the presence of a frothing agent makes an enormous difference in the behavior of air and water.

We shall now observe the effect of adding a minute quantity of oleic acid or mineral frothing agent of the first patent in suit.

Oleic acid has a modifying action that is indicated by the formation of smaller bubbles and masses of finely divided air, made up of minute bubbles, and the masses of air being apparent here that are entirely lacking in the unmodified water.

(23)

MAGNIFIED VIEW OF WATER MODIFIED BY OLEIC ACID.

We shall observe the magnified effect. There is

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the appearance at first sight of being slightly out of focus, but the larger of the bubbles that appear show that the focus is actually accurate, and that the cloudiness and haziness is due to minute masses of air being carried suspended through the liquid. These minute masses of air seem to aggregate themselves in groups and clots. The small bubbles hang on to the large ones, and are carried up or swept away, and are separated. The breaking up into these minute masses seems to be at least one of the important functions of the frothing agent. As we study these pictures, over a thousand of them, in the search for coalescence, we are forced to conclude that such is the case. This coalescence which makes any effective and suitable air entrainment difficult or impossible—this explosive coalescence which renders futile any effort of the mineral particles to adhere to the bubbles in pure water is notably absent. Even when large masses of air are specially introduced to observe their behavior, we find them first sweeping aside the smaller particles of air and then drawing the smaller particles into their wake without evidence of coalescence. The large masses do not grow in their progress, nor is there evidence of violent change of form similar to the explosive coalescence in pure water. The small bubbles of air gather into groups and masses without coalescence, and we can easily see how under these conditions mineral particles might be caught up and given the utmost opportunity to attach themselves to slowly growing air bubbles without the slightest violence or shock.

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The amount of coalescence actually occurring is even smaller than appears in the projected view that we have here, because the habit of the eye fails to separate the bubbles after they meet. In a very large proportion of those cases, so far as I have been able to observe them, the bubbles meet and are swept away again. They pass around each other, and separate. Even then, supposing all the bubbles that appear there individually as bubbles shortly coalesce, the enormous amount of finely entrained air is clearly apparent.

(24)

WATER MODIFIED BY PINE OIL.

In this case 1-10 of 1% of pine oil is used alone showing the same action as when later used with kerosene.

Similar views of the effect of pine oil will show that it is closely related to phenol (which we shall see later) in its behavior as a frothing agent. These pictures were taken in the same general way, in the same type of air lift cell as was used for the other pictures.

(25)

MAGNIFIED VIEW WATER MODIFIED WITH PINE OIL.

Clearly shown typical smoky, or forest fire, effect like that of oleic acid.

The magnification in all cases was substantially

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the same. The magnified pictures of pine oil alone, with kerosene, and with kerosene and Jones' Fuel oil (as well as of kerosene alone) were taken at much slower speed (about 40 pictures per second) and hence do not show up quite so well, but are strictly comparable among themselves and show the characteristic phenomena even though the bubbles seem to be rising more rapidly because the camera was run more slowly when tak~~en~~ing then.

(26)

KEROSENE OIL NOT A FROTHING AGENT.

Water containing first .05%, later .~~040~~ 0.4%. Note bubbles rise quickly and cloudiness is due only to emulsified oil, not air.

This confirms the statements so frequently made by experts for the defense that kerosene is not a frothing agent. More than that, it shows clearly how easy it is to emulsify kerosene and how lasting is this emulsion when produced. Such oils in a pulp subjected to violent agitation may be expected to break away their excess from both mineral particles and bubbles without that excess appearing on the surface as an oily float. Such emulsified oil would be expected to carry along in the pulp. We have seen that globules of oil are not readily seized upon by air bubbles, and that oil globules may easily not attach themselves to mineral particles. It is not difficult to comprehend how a relatively large proportion of the excess of such oil added in flotation

might disappear as emulsified oil in the circuit water and turn up as oil in the tailing slimes where it had been caught and sedimented out in the settling of these slimes.

(27)

KEROSENE OIL NOT AERATING AGENT BUT IS ITSELF EMULSIFIED.

View of same undisturbed emulsion an hour later shows that the cloudiness is not due to air which would separate at the surface, but due to oil emulsion.

The permanence of such an emulsion is here well shown by an hour's standing at complete rest. It would require the sedimenting action of alum, clay, or other finely divided powder such as gangue slimes, to carry down such minute particles of oil.

(28)

MAGNIFIED VIEW UNMODIFIED WATER IN PRESENCE OF KEROSENE OIL.

.05% at first, then 5%. Clearly shows large quick coalescing bubbles, proving absence of all modifying action.

This picture, taken just as the preceding magnified view of pine oil was taken, clearly establishes the statement that so far as concerns modifying the action of air and water to form minute bubbles, kerosene is wholly inert in the sense of harmless even to the amount of 5% on the weight of the water.

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(29)

PINE OIL EXCELLENT FROTHING AGENT WITH KEROSENE OR ALONE.

First is shown the effect of 1/10 of 1% pine oil on the same kerosene emulsion, formation small bubbles on surface or froth, is not prevented by kerosene.

We may ask whether kerosene has any detrimental effect on frothing and the materials themselves visibly answer, No. Pine oil was added to the same kerosene emulsion that has been shown and we see that agitation now produces an entirely different result. When formed the bubbles are slightly more stable than with pine oil alone, as would be expected with the pseudo viscosity of the film produced by finely divided mineral present, or with the true viscosity of film, produced by liquid mineral.

(30)

MAGNIFIED VIEW OF WATER MODIFIED BY PINE OIL IN PRESENCE OF KEROSENE.

Here we see conclusively that the presence of the kerosene does not in any way interfere with the action of the pine oil in producing the "forest fire effect." It will be remembered that oleic is an insoluble frothing agent and cresol is a more soluble agent and phenol is a still more soluble agent, and each successively give increasingly fine smokes. So, for pine oil, we would expect something between oleic

and cresol, or phenol, and in fact we find the bubbles are not quite so small as for some of the other frothing agents.

(31)

MAGNIFIED VIEW OF WATER MODIFIED BY ~~PURE~~ PINE OIL IN PRESENCE OF KEROSENE AND JONES' FUEL OIL.

Here we have confirmation of the inertness of at least one other mineral oil product so far as frothing is concerned, in the substantially unchanged behavior of the pine oil water.

(32)

WATER MODIFIED BY PHENOL.

We shall ~~should~~ now observe the effect of carbolic acid or phenol.

We shall, after its addition, see the white smoke that takes the place of flashing masses of air bubbles, and when we see the magnified view we shall note that the phenol solution produces, if anything, even more minute sub-division of the air, and a far more smoky effect.

(33)

MAGNIFIED VIEW OF WATER MODIFIED BY PHENOL.

Phenol has a somewhat different appearance from the oleic acid, but the general character of the effect,

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so far as the aeration of the water is concerned, is much like that of oleic, only there is a very great improvement in the fineness of subdivision.

As stated before, I think, when we look at these pictures, we must remember that the rate of taking, the time of exposure, the magnification were the same here as were used with the water unmodified, so that the air bubbles in the unmodified water as seen before are comparable in size by accurate measurement on the film, with the size of these infinitesimal particles of air that constitute the smoke. When this smoke is examined under a strong glass until we magnify it to the point of eliminating the picture entirely, and getting only the obscuring of detail by the granulation of the photographic emulsion necessary for a high speed film, such ~~and~~ magnification shows an increased clotting of the air but does not indicate in these ~~their~~ pictures any considerable number of bubbles of visible size included in the smoke.

The fluttering effect there is due to the spark, as it jumped from one to another side of the terminals. The scratches are due to points where the film slightly touched the camera, and moving at that ~~enormous~~ velocity almost anything would scratch the film.

(34)

WATER MODIFIED BY CRESOL.

We shall see all these general phenomena with cresol.

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(35)

MAGNIFIED VIEW OF WATER MODIFIED BY CRESOL.

We see nearly the same effect, as was given by phenol, when magnified. There are minute differences in appearance. The magnification, it will be remembered, is the same that was used for the unmodified water, and all the others, and the time of exposure and other things are constant throughout this "magnified" series (except for kerosene and pine oil)

With the cresol the effect is, as stated, much the same, but there appears to be a coarser granulation of smoke. At the same time, there is no practical comparison between the size of the bubbles as seen in unmodified water, and the particles as seen here. Some of the bubbles have stuck to the glass plate, as seen at the top, just to the right of the center, and it will be noted that they do not show any very material tendency to grow in size. The growth is extremely slow, even though they are battered and battered all the time by these multitudes of minute particles which are passing over them. There could be no better proof of the absence of coalescence.

(36)

WATER MODIFIED BY AMYL ACETATE.

We shall see in the same cell, as before, the clear agitation of the water unmodified, failing to entrain

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any material quantity of air and when the amyl acetate is added, the smoky effect appears. Also a surface froth is seen when the agitation is stopped.

(37)

MAGNIFIED VIEW OF WATER MODIFIED BY AMYL ACETATE.

In a similar way we will examine the magnified view of water modified by amyl acetate, one of the soluble frothing agents characteristic of the second patent. This makes a similar smoky appearance of air entrained with water very much like that of phenol when viewed either with or without magnification, either as we see it now or as we saw it in the cell. There is nowhere any suggestion of violent coalescence of the bubble. Large masses of air were introduced again to see their sweeping effect, and it appears precisely the same as was seen before. The large bubbles do not apparently grow materially in volume.

(38)

WATER MODIFIED BY ACETIC ACID.

This is one of the best modifying agents we have and is an exceedingly good mineral frothing agent for certain substances. It seems excellently to point the lack of justification for calling the process of air froth flotation an oil process, for vinegar (4% acetic) is in no sense oil.

(39)

MAGNIFIED VIEW OF WATER MODIFIED BY ACETIC ACID.

Shows clearly the same characteristic subdivision of the air that is shown by other soluble frothing agents, and greater fineness of division than given by the oily frothing agents.

(40)

PRACTICAL RESULTS—AIR BUBBLES PRODUCED IN MODIFIED WATER PICK OUT METALLIC PARTICLES AND REJECT GANGUE PARTICLES.

This is the practical result of the scientific phenomena we have seen.

We shall view the practical results of the facts as indicated, in a sort of typical schematic ore separation, dependent upon the selectivity of air bubbles for metal over gangue, in a liquid containing about one fourth of one per cent of sulphuric acid and .02 per cent of cresol. We shall observe the behavior of our captive bubbles toward various mineral and gangue particles. Side by side on the bottom of the cell will be seen a particle of galena, of pyrite, and of blende on the one side; while, on the other will be seen a particle of quartz, one of feldspar, and one of calcite.

The weights of the non-metallic particles are less

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than those of the metallic particles. The larger size and surface of the non-metallic particles typifying the gangue, give the air bubble the better chance for adhesion, should make the lifting power of the bubbles greater, and the surface tension line of application after adhesion greater with these non-metallic particles which are also of lesser specific gravity and should be relatively more easily floated.

We shall see the air bubbles seize upon the metallic particles, one after another, and reject the gangue particles one after another.

We first see the bubble approaching and raising the galena particle, and the galena particle then is shaken off by a jerk of the bubble holder. The air bubble will then repeat the performance in the case of the pyrite particle, and finally in the case of the blende.

This illustrates the powerful mineral lifting action of the bubble, and also shows clearly the fact that the particle, when once attached to the bubble, may be swung around and agitated to a truly remarkable extent (when the weight of these particles is considered) without detaching it. The air bubble will then be given an even greater opportunity to attach itself to each of the gangue particles. Having just picked up the galena pyrite and blende, we try the quartz as carefully as possible and fail to secure any lifting. The air bubble is carefully and completely brought in contact with the particle of quartz, brought clear down over it, and there is scarcely a trace of that

lingering adhesion; no visible evidence of strong attachment; no elongation of the bubble. We then proceed to the feldspar with a like result, and then to the calcite. The same painstaking care fails to secure the lifting of any one of the particles of quartz, feldspar or calcite typical of gangue particles.

It will be noticed that there is no such drawing out of the bubble or apparent effort of straining to lift, because there is no considerable adhesion.

(41)

OIL FROTHS.

We shall now examine the oil emulsion froth made with sufficient quantity of oil to entrap mineral and air (and largely magnified) to see whereof it is made and how it behaves. Although, as has been stated, the oil froths appear superficially not unlike air froths, we shall see the structure of the oil globules each entrapping the mineral particles. They lie the one over the other, separated by thin films of water, frequently entraining (within the globule itself, or between the globules) loosely held bubbles of air, which serve to give it an uncertain mass sponginess and an uncertain buoyancy.

This is an oil froth, in which air bubbles are apparent. It is being pressed and shifted between glass plates illuminated from the back ~~bottom,~~ so as to show the air, oil and water (the expelled part being chiefly air which comes out from between the oil masses) The

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oil masses continue to hold the mineral, but as the air is pressed out by any jar or shaking or any of the things which would in practice occur in the separation of a froth, the air leaves the oil owing to lack of adhesion of air for oil. Owing to the fact that the mineral is enclosed in the oil, and out of contact with the air, finally the whole mass breaks away and settles. There are a few stray objects going back up with oil attached to them, either a bubble of air entrapped by a mass of oil, or possibly a bubble attached loosely to the outside of an oiled mineral granule. An attachment of that character, as has been repeatedly observed with the air bubbles which are attached to the outside of such oil globules, is loose and is easily destroyed by shaking, agitation on stirring.

The mineral held within the globule itself is buoyed up partly by the oil and partly by air entrained either within the globule or between the globules.

We have seen how slight an attachment air has for oil masses, and we have seen how slight an attachment air has for mineral particles when covered by oil. We have now observed (when this oil froth was gently moved), how the air bubbles slip out through the masses of oil, and escape, carrying with them relatively little mineral, because the mineral is coated with oil, and has no substantial attachment for the air bubbles.

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(42)

AIR FROTHS.

In contradistinction to the oil froth, we shall see the air froth, and observe the different behavior of the mineral particles towards the clear masses, which are air bubbles. The large dark masses are coated air bubbles overlying one another. You can see, on these lower bubbles (for instance this one almost in the center) —that as the movement of the glass plates occurs, it seems to be elastic, like a rubber ball, and, being illuminated from the rear, the granulation of the mineral over the bubbles is very clearly observable. They and the mineral attached to their surfaces constitute the great bulk of the froth. There are no slippery masses of weakly attached oil. We shall see the metallic particles fringing the clear openings of air whenever we get a chance to look through the bubbles. We shall observe, as the froth is manipulated between the glass plate the buoyancy and power of air froth flotation in spite of the severe and repeated manipulations. We see how the bubbles move and expand or contract as the mass is manipulated, and we shall see them maintain their firm grip on the mineral particles held by direct attachment.

The oil froths and air froths may superficially appear not unlike. Critically examined, they are essentially different. The air froths are technical effects incomparably superior and radically different, both in practical result and in underlying principles.

P. 4590, L. 28, after "froths" insert "of the patent in suit"

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Some of the mineral can, of course, be detached from the air bubbles. It falls, as mineral always will fall, from any froth, when severely manipulated, but the froth, as a froth, remains floating.

A severe manipulation is used in this case, very much more severe than was used before with the oil froth. When the air comes back up, there are lines of mineral particles picked up and brought up with air bubbles. You see here (indicating) the mineral particles drawn up. Those masses coming in are air bubbles carrying on the under surface here (indicating) the attached mineral, and it is a clear illustration of the difference in behavior of the two froths in all operations to which they are likely to be commercially subjected. The oil froths hold the mineral in the oil, and subject to all the weaknesses of attachment of oil with respect to air. The air froth holds the mineral tightly attached to the surface of the air bubble itself, and, if circumstances permit, these air bubbles are capable of building up a froth structure. If circumstances are not such as to permit the building up of heavy, enormously mineralized froth structure, the result will be that the bubbles will go ahead and carry the mineral, will perform their function and carry out the characteristic process of air froths. Some of the superficial phenomena may be disguised, but when we examine how they behave in detail, there is that characteristic bubble action.

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Q. 374. Dr. Sadtler in his testimony made a brief reference to patent No. 793,808, issued to Sulman and Picard in July, 1905, which appears at page 724 of the record for the defendant in the Hyde case. He quoted from page 1, lines 65 to 79 as a description of gaseous flotation. What have you to say as to the kind of gaseous flotation which was described in this patent 793,808.

A. The kind of gaseous flotation described in this patent is the attachment of the gaseous bubble to such oil moistened mineral so that the bubble carries the mineral up to the surface of the water. There the bubble bursts One of two things happens to the mineral: It either sinks or floats on the surface of the water, just like the greased needle does, which is generally termed "skin flotation." There is in this patent no disclosure of any froth whatever. The froth could not possibly be obtained without the employment of gaseous bubbles. The specification in line 93, page 1, says: "It is therefore unnecessary in some instances to employ gaseous bubbles to effect flotation." The three examples of the patent illustrated in the drawing also result in the flotation of mineral by the skin flotation process.

Q. 375. You have at times used the expression "surface tension flotation." What is the meaning of that in the art?

A. That has the same meaning as the skin flotation term.

Q. 376. Then I believe there is a term sometimes

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used in this case, "film flotation." Is or is not that descriptive of the skin flotation?

A. Yes, that is a synonym.

Q. 377. Are you familiar with patent No. 962,678?

A. Yes, I am.

Q. 378. By what name is that patent usually known?

A. The solution patent.

Q. 379. Dr. Sadtler has testified that this patent discloses a process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral frothing agent, and agitating the mixture to form a froth and separating the froth. Are you in agreement with Dr. Sadtler in that answer?

A. Yes, I am.

Q. 380. What is the specific soluble frothing agent disclosed in this patent 962,678?

A. Amyl acetate is the soluble frothing agent mentioned.

Q. 381. Is phenol mentioned as one of the soluble frothing agents?

A. Yes, phenol and its homologues, benzoic, valerianic and lactic acids; acetones and other ketones, such as camphor.

Q. 382. Are you ready to carry out an experiment in accordance with the disclosures of this patent?

A. Yes.

Q. 383. And will you first follow the specific disclosures of the patent, using amyl acetate?

A. If you wish.

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Q. 384. Describe the experiment that you are about to do.

MR. KREMER: We object to this for the reason that it is incompetent, irrelevant and immaterial for any purpose whatsoever. We object to the experiment or any further testimony with reference to this patent. It tends to prove no issue in the case. I don't understand the purpose of it. The witness was asked if he agreed with Dr. Sadtler; that Dr. Sadtler mentioned the patent, and he said "Yes." There is no controversy. May I inquire the purpose, Mr. Williams?

MR WILLIAMS: Yes. The explanation of the operations that have been carried on by the defendant and others with the employment of large quantities of inert oils is partly to be found in the fact that in all of these operations a soluble frothing agent is employed. The soluble frothing agents exercise a peculiar co-operation with the inert oil. We have exhibited the interior structure, you might say, of the kind of bubble-forming operation which characterizes the soluble frothing agents, and we propose now to show the operation of the soluble frothing agents so that your honor may understand. We deem it to be important, by way of explanation of these operations alleged to represent the prior art, and in fact involving the process of the patent in suit and something else, and we propose to show, as far as possible, what that something else is.

MR. KREMER: On the statement of counsel we renew our objection, adding the additional objection

that there is absolutely nothing that has been testified to with reference to the existence of a soluble frothing agent in the prior art, and that there is nothing in the patent in suit which would justify the introduction of any such testimony. That is the subject matter of another suit recently filed in this court, and has no place in this trial. It does not tend to prove anything. There is no limitiaton in the patent in suit upon the use of anything other than the reagents specified in that patent and within the quantities that are specified.

MR. WILLIAMS: Just briefly. The defendant has introduced into this case experiments with frothing agents in solution. Every large scale operation carried on under any working conditions has been characterized by the presence of those soluble frothing agents, and the defendant having brought it in, we wish to explain it. Of course the question as to whether or not the defendant is infringing that patent is entirely excluded from this suit. We do not intend to go into that and we have not gone into it.

THE COURT: Has it appeared to the court that these experiments of the defendant, or their working operations, have been, as you now say, conducted with soluble frothing agents, or is that something the court is to take judicial notice of?

MR. WILLIAMS: I think it has quite well appeared that phenol, which is present in all wood tars and coal tars, has been used in these experiments, and the witnesses for the defendant have admitted that

phenol has been present in these wood tars and coal tars that they have used. A witness for the defendant has admitted that pine oil is partly soluble, and these experiments or these operations are all characterized by the presence of either creosote, wood tar, coal tar or pine oil, so that it has appeared that all these operations involve the use of frothing agents in solution, or soluble frothing agents.

Prof. Bancroft, I might say, also did experiments with acetic acid and alcohol, illustrating this operation with soluble frothing agents. It seems to me the condition of the record is such that your honor has been informed and that the defendant has injected the soluble frothing agents into the case.

MR. KREMER: If it is not disputed, as you seem to say, what is the relevancy of this testimony?

MR. WILLIAMS: We wish to explain the action of soluble frothing agents.

MR. KREMER: If that is not in dispute—Certainly by your own statement you admit that there is nothing in dispute.

THE COURT: Is it a question in this case somewhere whether oil in amounts above 1% is or is not an infringement of the patent? Is that question likely to arise and is it likely to be a contention that it is, and that amounts of oil above one per cent are to be accounted for on the theory of inert oil and some soluble frothing agents? If so, perhaps this is admissible. However, if there have been experiments, and there have been with alcohol at least, I will allow

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this experiment to be made, and if it be entitled to no consideration, the court will give it none in making up its decision. The objection will be overruled.

Defendant excepted.

MR. WILLIAMS: For the purpose of abbreviating the experiment I will ask you to perform the experiment with phenol?

A. Yes, that can be done.

Q. 385. And will you describe what you will do with phenol, as that is a specific thing that the experiment testified to by the defendant have used.

A. I shall take 2000 c.c. of water at about 40° C., dissolve in that 1.87 c.c. of phenol, making .1 per cent of phenol in the solution, add to that 4.5 c.c. of sulphuric acid. After a short agitation to mix the material, I shall put in 400 gms. of Broken Hill tailings crushed to 100 mesh and agitate for five minutes at about 850 r. p. m.

Q. 386. And as to the result so far as you will see it in the Gabbett, will that or will that not be substantially the same as of amyl acetate, the specific disclosure in this patent?

A. It will be substantially the same.

MR. WILLIAMS: I would like your honor to observe the operation of the Gabbett with nothing but pure water in it. If your honor will look down you will see that the vortex opens down to the very bottom of the vessel, and you now see the bubbles such as pure water produces, the large bubbles that coalesce and break, unmodified water bubbles.

THE WITNESS: I have now added the sulphuric acid.

Q. 387. Is there any difference in the bubble formation as a result of the addition of the sulphuric acid?

A. No, it is just the same.

Q. 388. Is sulphuric acid a mineral frothing agent?

A. No, it is not.

Q. 389. Now, please state what you are about to add?

A. I am about to add now 1.87 c.c. of melted phenol.

MR. WILLIAMS: I will ask your honor to observe the immediate change in the bubble formation from the addition of the soluble frothing agent, the different appearance of the bubbles and the clouded effect.

THE WITNESS: I now add 400 gms. Broken Hill tailings crushed through 100 mesh.

Q. 390. MR. KREMER: What is the degree of agitation?

A. Now, about 850 r. p. m.

Q. 391. MR. KREMER: What was it before you put in the phenol?

A. About 600.

Q. 392. MR. KREMER: Why did you increase it?

A. The lower speed was merely to make the solution of the phenol effective. That doesn't require any powerful agitation.

Q. 393. MR. WILLIAMS: Have you checked up the number of revolutions, Mr. Higgins?

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A. Yes. The motor is running about 80 r. p. m. too many, and that will make about 70 revolutions too many in the cone, makes probably about 900. I think we might stop at the end of four minutes so as to take off the effect of the extra speed.

Q. 394. What was the actual time of agitation?

A. Four minutes and a quarter.

Q. 395. Now, what you have obtained as a result of this operation?

A. About an inch and a half or inch and three-quarters of good froth, and very clean tailings. There is two inches of froth.

MR. WILLIAMS: Will your honor observe the tailings? They are settling now.

Q. 396. Now, will you remove the froth so that it can be separated and assayed?

A. Yes.

Q. 397. THE COURT: What is the ordinary name for phenol, carbolic acid?

A. Carbolic acid.

Q. 398. What sort of a material is phenol?

A. Phenol is a crystalized solid which melts at about 104° F., just a little higher than the temperature of the body. It dissolves to the extent of about 6 per cent in water, and the addition of a little water to the phenol makes it into a liquid. The material which we use was made liquid by melting it, that is by rasing the temperature above 104° F. When it is dissolved in water in the proportion given in the patent

and even less, it makes an excellent mineral frothing agent.

Q. 399. What is your experience in the use of phenol as to whether or not an excess of phenol above the minimum required for mineral froth production but below the point at which it will not dissolve, effects the mineral frothing operation?

A. There is no difference whatever in the result or in the way in which the results occur; that is to say it does not happen any quicker or any slower.

Q. 400. The phenol when used in soluble proportions is it or is it not precipitated upon the metallic particles in the operation?

A. No, the phenol is found in the solution, not on the particles.

Q. 401. At the conclusion of the operation you did not find the phenol on the particle?

A. No, only such phenol as is in the water that is contaminating the particle.

Q. 402. So that the solution still contains the phenol?

A. The solution still contains the phenol and may be used over and over again.

Q. 403. And in that respect how does it compare with the insoluble oil frothing agent? Where do you find that at the end of the operation?

A. That oil is found at the end of the operation on the concentrate chiefly. A very small portion may be found in the tailings, but the water is particularly free from it and is no longer useful as a frothing agent.

That makes a big contrast in the solution patent where the frothing agent remains in the solution and the solution can be used over again usefully.

Q. 404. Now, when you employ an oil or insoluble frothing agent, are there any conditions under which the gangue uses oil or consumes oil?

A. Oh, yes. It depends a good deal on the nature of the gangue and on the nature of the reagent that was put in to keep the oil off the gangue. The use of sulphuric acid is specifically for the purpose of preventing the oil from attaching itself to the gangue, and if insufficient is used of course some of the oil becomes wasted in this way.

Q. 405. What is the effect of a clay gangue?

A. It is very difficult to prevent clay from absorbing oil. Frequently the presence of the acid is insufficient, unless the acid happens to be in very strong solution.

Q. 406. When oil is absorbed by the clay or other gangue, has it any further utility in the process?

A. None whatever; in that condition it is absolutely useless.

Q. 407. What has been your experience with kerosene as a mineral frothing agent?

A. Kerosene is not a mineral frothing agent.

Q. 408. Are you ready to show that by experiment?

A. Yes.

Q. 409. Describe the experiment that you are about to do.

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A. I shall take 250 c.c. of water at about 40° C., and add to that 60 gms. of Butte & Superior ore handed to us by Mr. Dosenbach on the 25th of April .16 c.c. of sulphuric acid, being 8 lbs. to the ton of ore; and .15 c.c. of copper sulphate solution, which we obtained from the Butte & Superior plant on the 29th of April. I shall agitate that for half a minute, then we will add thereto .075 c.c. of kerosene, which is 2 lbs. to the ton, and agitate the mixture for two minutes, and it will be seen that there is no froth.

Q. 410. What is the apparatus in which you will carry on the experiment?

A. A bar mixer similar to the bar mixer used by Mr. Phillips. The agitator in this bar mixer runs practically the same speed as his did, which is between nine and ten thousand revolutions a minute.

Q. 411. Did you make that determination with Mr. Phillips' bar mixer?

A. I measured that one at 9500, and this one about 9800.

MR. WILLIAMS: Mr. Phillips was a little wrong in his estimate.

Q. 412. Can you give me some idea of the peripheral speed of the agitator in the bar mixer?

A. It is about 1800 peripheral feet per minute.

Q. 413. What are you putting in now, Mr. Higgins?

A. The kerosene.

Q. 414. What kind of kerosene is it?

A. It is kerosene that we bought here at one of

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Lutey's stores in Butte. I took the specific gravity of the kerosene at .82.

(Experiment performed.)

Q. 415. Now how long was the agitation done?

A. Two minutes.

Q. 416. And what is the result?

A. Everything is sunken; there are two or three bubbles on the surface—three—four I see. This is two pounds to the ton, or one-tenth of one per cent of oil. Now, we will add to that two pounds to the ton of pine oil, which is .07 c.c., and re-agitate two minutes.

Q. 417. Is that the settlement of the slimes?

A. Yes, that is the slime settling.

Q. 418. Is there enough kerosene there to show as a layer?

A. No.

(Re-agitation performed.)

Q. 419. Now, what have you produced as the result of adding one-tenth of one per cent of pine oil and re-agitating for two minutes?

A. A mineral-laden froth floating on the surface of the pulp, and a fairly clean tailing sunk to the bottom.

Q. 420. BY THE COURT: Would it have been any different without the kerosene?

A. Possibly it might be a little less. The coarser material has a tendency to fall out in the absence of sufficient oil to keep it there. We could get the same result with about four pounds of pine oil.

Q. 421. BY MR. SCOTT: You mean that the kerosene helps to keep the mineral from falling out of the froth?

A. Yes.

Q. 422. MR. WILLIAMS: Does the kerosene assist in the froth formation?

A. In small quantities it stabilizes the froth and prevents what we call showering, that is, the dropping out of the coarser particles from the froth.

Q. 423. State whether or not a mixture of kerosene and Jones' oil is an efficient froth froducer.

A. It is not, and I would like to show a similar experiment, showing that the Jones' mixture with kerosene does not make a froth, while the addition of pine oil brings up the froth.

Q. 424. Describe the experiment that you are about to do.

A. I shall take, as before, 250 c.c. of water at 40° C.; 60 gms. of Butte & Superior ore handed to us by Mr. Dosenbach on the 25th of April; .16 c.c. of sulphuric acid; .15 c.c of copper sulphate solution we obtained from the Butte & Superior plant. To that I shall add .61 c.c. of Jones' heavy mineral flotation oil, purchased by us from the Jones Company in St. Louis, mixed with Mineral Separation kerosene that we purchased from Lutey's in the ratio of 70 gms. of Jones' oil to 12 gms. of kerosene. The specific gravity of the mixture is .88. The pulp will be agitated for four minutes and the result observed.

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Q. 425. What do you mean when you said "Mineral Separation" kerosene?

A. Well, just as a distinction from anything that was given to us by the other side.

Q. 426. And this you purchased where?

A. At Lutey's store.

Q. 427. MR. SCOTT: I would like to have you look at the settlings of the gangue in this jar, and ask you if that isn't comparatively—and ask you if in that comparatively quick and well defined settlement you find evidence of a clay gangue you have spoken of?

A. That heavy clayey gangue is rapidly settling due to the flocculation by absorption of oil. That is a very common occurrence and is well recognized by metallurgists who have anything to do with this kind of operation.

Q. 428. You mean the oil is a usual flocculator? Is it used for that purpose?

A. No, I don't think so, not used purposely for flocculating clay slimes. Of course, clay rapidly absorbs oil, and it is well known that such occurs, and large deposits are found with solidified clay with the oil absorbed, known as oily shales and that kind of thing.

Q. 429. How would you describe the condition of the tailing here, consolidated or colloid?

A. I am not an authority on colloids. As for being colloids, my understanding of a colloid is that it is so near the solution it don't settle like that, although I do not pretend to be an authority on colloids.

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Q. 430. MR. WILLIAMS: What is actually taking place in this jar now?

A. Settlement of the slimes.

Q. 431. A settlement under what condition?

A. The flocculated slime is settling through a very small quantity of slime that is not flocculated. The unflocculated slime renders the water slightly opaque, whereas the flocculated slime is coming down in a heavy layer.

Q. 432. So that it almost looks as though it were solid sand up to the point where it is going down you mean?

A. Yes. That condition can be brought about by the addition of various things to the ore.

Q. 433. MR. SCOTT: Isn't it a fact, Mr. Higgins, that if you simply stirred this pulp without any oil at all but simply with the same sulphide acid—you have sulphuric acid in there?

A. Yes.

Q. 434. Wouldn't those tailings settle just as quickly as they have settled?

A. Not quite so quickly, in my opinion. I should like to observe that this ore was handed to us by Mr. Dosenbach to repeat Mr. Phillip's experiment with, and is extremely unusual in the fact that it contains alkali which is soluble in water. In my opinion the presence of that alkali would have a tendency to increase that flocculation and render it more rapidly settling. The ore that you gave us in March, 1912, or 13 does not contain any alkali soluble in water, neither does the

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ore which we received here in March, 1917. The reason I used that particular ore was that I am not satisfied that the ore we received here in March, 1917, represents the ore that is being treated in the plant, whereas it is fair to assume that as they used it in their experiments that it is very natural that we needn't suspect it.

Q. 435. MR. SCOTT: Is it usual, Mr. Higgins, to get ore running identically the same in analysis, day after day, month after month, and year after year, from any mine?

A. It is quite unusual, but on the other hand it is something new to me to find ore coming out of the mine with alkali in it.

Q. 436. Have you made an acid or alkali determination of this ore?

A. I only have determined the presence of the alkali; I have not determined the quantity.

Q. 437. Used litmus paper?

A. No. Mixing the ore with water, distilled water, and then treated that with phenol phthalein, which gives a deep red color in the presence of alkali.

Q. 438. Isn't it a fact that you get an acid or alkaline reaction of almost any ore with a delicate test of that kind?

A. No, the same water shows deep blue to litmus, neutral litmus, which also is an indication for alkali, and it is not my experience that ores do contain naturally alkali material.

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Q. 439. MR. SCOTT: Is that acid now?

A. No, it is neutral.

MR. KENYON: It is stipulated that the several instruments in writing referred to in the supplemental bill of complaint in paragraph 3 thereof, and copies of which are annexed to said supplemental bill of complaint as Exhibit "A" and Exhibit "B" were executed and delivered as there alleged, and that said contracts were fully executed as there alleged, and particularly at the times alleged in said paragraph 3.

MR. KREMER: That is satisfactory.

THE COURT: The record may show.

MR. KREMER: That is all subject to the one objection to the supplemental bill, as to its general competency. There is a general objection interposed there and we do not want to waive that objection.

Q. 440. MR. WILLIAMS: Mr. Higgins, when you described the ore that you are going to use in this experiment, you did not tell us what it was given to you as. Was it or was it not the same ore that was used in Mr. Phillips' experiment?

A. That is what I understood. That is what I asked for from Mr. Dosenbach, and I understood we got it.

Q. 441. That is not the same specimen that was given to you at that time?

A. No, we used that.

Q. 442. But a larger specimen that you asked Mr. Dosenbach to give you and of the same ore? Is that right.

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A. Yes.

Q. 443. That Mr. Phillips used in his kerosene froth?

A. Yes.

Q. 444. Have you told us the proportion of oil to ore in this experiment that you are about to carry on?

A. No. That is 82 per cent of 22 pounds to the ton. Later we shall add the balance of the 22 pounds which will be 18 per cent of 22 pounds, of pine oil.

THE COURT: What is this 22 pounds?

A. I am going to make a total of 22 pounds of oil to finish with. First we shall add the Jones and kerosene proportion, which is 82 per cent of the 22 pounds and then afterwards, when we have agitated it first, we shall add the balance of that 22 pounds in the form of a pine oil.

Q. 445. MR. WILLIAMS: And then when you have added the pine oil what will you have, what mixture?

A. A mixture of 70 per cent Jones' oil, 12 per cent of kerosene and about 18 per cent of pine oil.

Q. 446. And that mixture will be used in the proportion of how many pounds to the ton?

A. Twenty-two pounds to the ton.

Q. 447. And is that defendant's mixture as testified to here?

A. If there is any difference it is possibly in the Jones' oil. Jones' oil has got so many names that I don't really know which one they used when they say

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"fuel oil," so that I have taken one from you Jones so that ~~on what~~ I know exactly what it is.

Q. 448. Did you examine the specimens of kerosene oil that you obtained from the defendant?

A. Yes, I did.

Q. 449. What did you find in them?

A. I found in the sample of kerosene that was used by Mr. Phillips some soluble frothing agent.

Q. 450. And what did you find in the large specimen from the plant that you received?

A. I examined that also and a soluble frothing agent was in it. As I remember, Mr. Dosenbach said there was no great care exercised as to what tank they put the oil in. That is what I understood him to say.

Q. 451. And what would be your explanation of the presence of a soluble frothing agent in the kerosene?

A. The presence of some pine oil, as it got into the kerosene. It was probably left in the tank, perhaps only a little in the bottom of the tank when the kerosene had been emptied into it.

Q. 452. Mr. Higgins, when Mr. Phillips carried on his experiments, he operated the bar mixer so that it was revolving when it entered the pulp, and was also revolving when it left the pulp. Have you repeated that part of his operation?

A. Yes, I have. I find that the difference in the operation does not make a great deal of difference in the results, although there is some advantage in drawing it out, except for the splashing. The froth is

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ikely to be somewhat coarser on the surface when you lraw the revolving mixer through the liquid.

Q. 453. Now, in your experiments, have you done nything of that kind? What do you do?

A. I prefer to leave the agitator in position and stop t by breaking the current.

Q. 454. And in your experiments do you start the gitator in motion when it is in position and keep it here during the operation and stop it while it is there?

A. Yes, I do.

Q. 455. And do you or do you not regard that as he best representation of the proper operation?

A. In my opinion that is the best way to do it.

Q. 456. MR. SCOTT: That is settling just as quick vithout the oil as the other did with the oil. Isn't it?

A. Yes; there is not much difference in the rate of settling, but I think I have stated that that is due to his alkali.

Q. 457. The mysterious alkali?

A. It is not mysterious, in my opinion.

Mr. Williams (Experiment performed.)

Q. 458. About how many pounds of oil to the ton of ore were present in the operation which you are now conducting?

A. It is about 18 pounds of a mixture of Jones and kerosene oil.

Q. 459. And when you repeat the operation and add pine oil, about how many pounds per ton will you add of pine oil?

A. About four pounds to the ton, making a total of twenty-two pounds.

Q. 460. Now, what is the result of the four-minute agitation?

A. There are a few bubbles on the surface of the pulp carrying mineral, but there is no thickness of froth there. The general result seems to be a film of mineral floating on the surface, carrying a few bubbles.

Q. 461. As a metallurgical result has that any value?

A. None whatever.

THE COURT: Is this a repetition of one of those experiments performed by the defendant?

MR. WILLIAMS: Yes sir, it is a repetition of defendant's operation without the actual frothing oil. Now, we have transmitted light through it and your honor can see that the film is very thin, practically of no value.

Q. 462. MR. WILLIAMS: Now, what are you going to do?

A. I am going to add to that .13 c.c. of pine oil which will be about four pounds to the ton, and reagitate for another two minutes.

(Experiment performed.)

Q. 463. What is the result of the addition of four pounds of pine oil and the reagitation?

A. That has brought up to the surface of the pulp, a heavily mineralized froth, which appears to be rather denser than in the case of the kerosene and pine oil alone, the previous experiment.

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Q. 464. That is to say, comparing this experiment ith the kerosene with fuel oil and pine oil with the her experiment with kerosene and pine oil alone you nd this froth—

A. More compact.

Q. 465. And how about the recovery as indicated the appearance?

A. I think it is a little less, but there is not any aterial difference.

Q. 466. Is it or is it not a good recovery.

A. It seems to be a very good result as far as the covery is concerned.

Q. 467. MR. SCOTT: Will you describe the under rt of the froth, its appearance as to stability and so , its general characteristics throughout?

A. The froth is, as I said before, more compact as mpared with the last experiment. It does not show y free oil, although one can detect the smell of the l in the concentrate. It does not grease the hand in uching it. The undersurface of the froth shows an pearance which we usually ascribe to the presence too much oil of some kind or another.

Q. 468. Is this the condition that would prevail in e first cell of the machine where over 1 per cent of l was being used, the same quantity that is used here, pounds?

A. What kind of machine?

Q. 469. The Janney machine, in your experience?

A. Well, I think there would be a little difference, pending a great deal on the operations and the dif-

ferent conditions you have got there. I think if you will allow the machine to overflow before the mixture has got so thoroughly agitated as it seems to have been here, that you would have a little more free oil, and that might show on touching it with the hand—you might find some free oil there.

Q. 470. Is this what you call an agitation froth, or air froth, whatever expression you use?

A. In my opinion that is an air froth.

Q. 471. How much oil was used—22 pounds to the ton?

A. Twenty-two pounds to the ton.

Q. 472. If that was made entirely with pine oil, 22 pounds per ton, would it still be an air froth?

A. I think I could tell you better if I saw it.

Q. 473. You saw a test of it the other day, the result of the operation that was carried out, the experiment?

A. Well, one has always to consider the operation and the result together.

Q. 474. Did you ever try 22 pounds of pine oil or over 1 per cent?

A. No, I have not.

Q. 475. Did you ever try over 1 per cent of any oil other than this that you have before us?

A. Oh, yes.

Q. 476. What other one?

A. Particularly oleic acid and cottonseed oil.

Q. 477. Yes, I remember the cottonseed. Was that an air froth, an agitation froth?

A. When we got up to 3.6% of cottonseed oil on

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the Butte & Superior ore, we did not get any froth at all.

Q. 478. How about the Elm Orlu ore?

A. I haven't tried it at all.

Q. 479. Didn't you try that?

A. Oh, you mean that test at the Butte Reduction Works. There there was some froth, yes.

Q. 480. You testified about that in the Hyde case?

A. Yes.

Q. 480½. You got what you called the typical froth, didn't you, with cottonseed?

A. I don't think I described it that way. As far as my memory serves me, I said at a distance of several feet I could not distinguish the difference.

Q. 481. BY MR. WILLIAMS: Mr. Higgins, did you attempt to repeat the experiment made in court by Mr. Phillips, wherein he used kerosene in the proportion of 25% of oil to the ore?

A. Yes, I did. I took the material which was supplied to us as samples of the materials used, and went to the laboratory with the machine which we borrowed from them.

Q. 482. The same machine that he used?

A. The same machine that he used, and made a test. With their materials I got the same results that Mr. Phillips got. On attempting to repeat that with the ore that we had been supplied with—

Q. 483. When?

A. During that day, that of Mr. Phillip's test.

Q. 484. And in response to a request for what—a further quantity?

A. This was the first quantity of ore we received. Mr. Dosenbach handed me the balance of the sample which was used in those tests, and there was sufficient there for two or three experiments. On attempting to repeat that operation with the kerosene we had in the laboratory, I found that we could not obtain any froth worth speaking of. There was no floating stuff on the surface of the water more than 3/16 of an inch; so that I requested a further sample of the same kind of ore, and made a great number of experiments to find out in what way I differed from the test in getting this result. I had sent from San Francisco a sample of kerosene from the Union Oil Company, sealed up so that it was exactly in the condition that kerosene is produced at the refining company's plants. I bought six different kinds of kerosene in Butte from different stores. There was no special purity requested; it was just the ordinary kerosene of commerce. I found that none of those contained any soluble frothing agent, but that the kerosene used by Mr. Phillips in his experiment contained a small amount of soluble frothing agent that was sufficient to produce the result obtained. I took a small quantity of the oil—we then had only a few c. c. left—and separated the soluble frothing agent by shaking it up with distilled water and filtering off the kerosene until the solution was perfectly brilliant; that is, it did not contain any kerosene globules. The solution was then concentrated for me by Dr.

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McIlhaney; although we were not able to isolate the soluble frothing agent present, we found that the concentrated material smelled varnish, which was probably due to some pine oil.

Q. 485. Now, in repeating this experiment with these other kerosenes than that which Mr. Phillips used, what results did you obtain?

A. Well, in every case there was a certain amount of floating material, perhaps 3/16 of an inch thick, which was chiefly oil-carrying mineral, something like the Kirby float.

Q. 486. Of any value metallurgically?

A. Very little value. The bulk of the oil and mineral sinks to the bottom of the vessel and looks somewhat like very soft granules.

Q. 487. Now, will you describe the experiment that you are about to do?

A. I shall take 250 c. c. of water at the normal temperature, between 15^{c} and 16^{c}; 60 grams of Butte & Superior ore which was handed to us by Mr. Dosenbach on the 25th of April; .16°c. c. of sulphuric acid, which is 8 pounds to the ton of ore; .15 c.c. of copper sulphate solution as obtained from the Butte and Superior plant. Then I shall mix that for half a minute, as Mr. Phillips did, and to that I shall add 18.6 c.c. of kerosene, which is 25% to the ore, and then agitate 4 minutes. I find that the temperature of the water is just below 15; it is about 14¾.

(Experiment performed.)

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Q. 488. What is the result of that four minutes' agitation?

A. Some kind of a float about 3/16 of an inch thick on the surface of the pulp. The bulk of the oil and mineral and gangue is on the bottom of the vessel.

Q. 489. And this is a repetition of Mr. Phillips' 25% kerosene oil operation?

A. Yes, with ordinary commercial kerosene. Free oil is showing on the surface of the floating material.

Q. 490. What sort of an operation is that metallurgically?

A. As it stands, useless. Now, I would like to show the addition to that of .07 of a c.c. of pine oil, being 2 pounds to the ton of ore, and we will re-agitate it for a couple of minutes.

(Experiment performed.)

Q. 491. Now, what has been the result of the addition of the pine oil?

A. Now, practically the whole of the mineral and oil has risen to the surface of the pulp. There is clean gangue at the bottom. There is some very distinct oil-mineral globules or whatever they are mixed up with it.

Q. 492. How does what you have now obtained compare with what Mr. Phillips obtained?

A. I think it is about the same. Perhaps there is a little deeper layer of floating material.

Q. 493. MR. SCOTT: Would this result have been the same if you had used the pine oil only, and not used the other oil with it, the kerosene?

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A. As regards the nature of the froth, no—that floating material, whatever it is called. I don't know whether it is froth. It seems to me to be a magma.

Q. 494. You don't call that a froth?

A. No, I call that a magma. It is simply paste.

Q. 495. Is there no air in this at all?

A. Yes, oh, yes, there is air in it.

Q. 496. Is it a question of the relative amount of air that determines in your mind the difference between a magma and a froth?

A. Not entirely. I think one has to consider the amount of oil.

WHEREUPON an adjournment was taken until 2:00 p. m.

2 o'clock p. m., May 12, 1917.

MR. WILLIAMS: I would like to withdraw Mr. Higgins until after the completion of the cross-examination of Dr. Grosvenor, as to the moving pictures, and Mr. Scott is not quite ready to proceed with that examination now, and therefore I would like to put on another witness.

JAMES WILDING, a witness called on behalf of the plaintiff, after being duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. What is your name, age, residence and occupation?

A. James Wilding, age 47; residence 101 Edith street, Oakland; occupation, metallurgist.

Q. 2. What has been your experience and training as a metallurgist?

A. My training commenced with an apprenticeship of three years to a well-known consulting chemist in Liverpool, England.

Q. 3. Give the name.

A. Edward Davis. After that I studied two years in Freibourg, Saxony, as a special student in metallurgy. I went to Mexico in 1894, and was in the service of several companies for a number of years in that country, and also in independent business.

Q. 4. Give the names of those companies.

A. The first company was Cia de Minas Michoachan.

Q. 5. And in connection with the name of each company, state what the nature of your duties with that company was?

A. I was at first assayer and chemist, and then assistant superintendent of the smelting plant of the

P. 4623, L. 26, insert " : for the third I was superintendent" after " superintendent "

James Wilding.

Cia de Minas Michoachan. Next I was for some seven and a half years with three different Guggenheim companies in Mexico; first, the Guggenheim Smelting Company; second, the American Smelting & Refining Company; third, the Guggenheim Exploration Company.

Q. 6. And what was the nature of your duties with those companies?

A. I served as assayer and chemist for the smelting plant, and ore purchasing agent, and in mine examining and valuation work.

Q. 7. Now, continue with your further experience after that.

A. I was in the service of the Cia Metallurgica de Torreon for some two and a half years as assistant smelter superintendent and representative of the company in Europe. I have also been for short periods in the service of other companies, among others the Mexican Gold & Silver Recovery Company, the Cia Minera de la Trinidad and Cia Minera de Promentorio.

Q. 8. And what was the nature of the work you did for those companies?

A. For the first of those I was chemist; for the second I was superintendent of a hypo leaching mill. In 1912 I was superintendent of a smelting plant for the Cia Minera de Terrazas.

Q. 9. What were your duties there?

A. I was metallurgical superintendent, and in fact complete superintenednt of the smelting plant.

Q. 10. And after that?

A. I left Mexico in February, 1913, and a few months after that I entered the service of Minerals Separation Company, in which I am still.

Q. 11. What have your duties been in the service of Minerals Separation Limited?

A. Investigation of the treatment of ores, and also in the field, starting up plants for experimental purposes, and supervising operations.

Q. 12. Where the flotation process of Minerals Separation was being installed?

A. Yes.

Q. 13. And where has your work in the laboratory been done?

A. In San Francisco.

Q. 14. In what laboratory there?

A. The laboratory of Minerals Separation Company.

Q. 15. What sort of work is done in that laboratory?

A. Mainly flotation testing work.

Q. 16. With how large a staff?

A. Well, that varies according to the number of men that are out in the field or in town.

Q. 17. Varies from what to what?

A. Oh, from two to four or five.

Q. 18. Mr. Wicks of the Chino Copper Company, comparing efficiencies of operation at the Hurley plant of this company, November 18th, 19th and 20th, 1916, in treating vanner concentrates (when he says

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that 23.7 pounds of ore per ton of feed was used) with that of the third quarter of 1916 (when he says that 8.7 pounds was used), as both these periods are shown by the figures given by him on defendant's exhibit 29—said in answer to questions 25 and 26 that the latter period (that is with 8.7 pounds of oil) shows somewhat poorer results. Please compare his figures as given on that exhibit for those three days when 23.7 pounds of oil were used with his figures as they are given for the month of October, 1916, when 10.26 pounds of oil was used, being the nearest complete month, and also with his figures there given for the third quarter of 1916, being the nearest complete quarter, and state what the fact is as to whether or not the smaller oil quantities showed on the whole the poorer metallurgical operation?

A. No.

Q. 19. In other words, interpret for us the figures Mr. Wicks himself gives on this exhibit in that regard and compare them as to value of results by taking some common standard in such way as to eliminate the fluctuation of market price from time to time?

A. As a comparison, starting with a different amount of copper in the heading, the only method of comparison that occurs to me is to take the cost of operation, considering in that cost of operation the cost of smelting the concentrate produced and the losses in the tailings. In the third quarter of 1916—

Q. 20. You have prepared a table to show what you are about to explain, have you?

James Wilding.

A. Yes.

MR. KENYON: The plaintiff's counsel offers the table prepared by the witness in evidence and it is marked exhibit 255.

Table admitted in evidence and marked PLAINTIFF'S EXHIBIT 255.

Q. 21. Will you please explain the comparison you have made, its method and the results?

A. I have taken from exhibit 29 of the defendants, the tonnage given for these three periods of heading to flotation, the copper assays of the same, the tonnage of flotation concentrate, and copper assays of the same. I then calculated the contents of the heading in copper in pounds.

Q. 22. That appears in the third column, does it?

A. It appears in the third column.

Q. 23. And is a mere computation obtained how?

A. By multiplying the tonnage by its assay.

Q. 24. In each case?

A. In each case.

Q. 25. And you say the tonnage and assay are taken from exhibit 29?

A. Yes.

Q. 26. Proceed?

A. Next I have recorded in the fourth column the ratio of concentration by dividing the tons of heading by the tons of concentrate.

Q. 27. That is a mere computation, is it?

A. Yes.

Q. 28. From the figures given on exhibit 29?

James Wilding.

A. It is from that statement direct. The contents of the concentrate have been calculated in the same way as the contents of the heading.

Q. 29. That is the third column here flotation concentrate, contents pounds of copper?

A. Yes.

Q. 30. And you got that figure in pounds by multiplying what together?

A. Multiplying tonnage of flotation concentrate by the assay of the same.

Q. 31. Now, proceed.

A. I have figured the recovery of copper by the ratio of the contents of the concentrate to the contents of the headings; that is to say, I have divided the contents of the concentrate by the contents of the headings and expressed it in percentages.

Q. 32. That is the content of the concentrate in copper?

A. Yes.

Q. 33. And the content of the headings in copper?

A. Yes.

Q. 34. That being the copper that has been actually obtained by the flotation operations out of the copper originally in the feed?

A. Yes.

Q. 35. And that figure appears in the first column of the two under the head recovery percentage copper?

A. Yes.

Q. 36. Namely, calculated by contents?

A. Yes.

James Wilding.

Q. 37. Proceed?

A. The second figure—

Q. 38. Before you proceed, is that a proper way to figure recovery?

A. Yes.

Q. 39. The most proper way?

A. Yes.

Q. 40. That is the copper that went into the flotation operation and the copper that actually came out of it.

A. Yes.

Q. 41. And went to the smelter?

A. Yes.

Q. 42. It gives you the real recovery, does it?

A. Yes, the real recovery.

Q. 43. Proceed.

A. In the next column under recovery per cent ~~column~~ copper I have given the recovery of their exhibit 29.

Q. 44. To the extent that there is any discrepancy between the two which represents the real recovery—as you have calculated it, or as exhibit 29 gives it?

A. There is considerable discrepancy.

Q. 45. And which represents the real recovery?

A. The real recovery over any continuous period of operations can only be calculated by the ratio of the copper actually in the concentrate produced to that of the copper in the heading to the mill.

Q. 46. And that actual ratio is found in the per-

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tenage—that actual ratio to the feed is the percentage in the first of these two columns?

A. Yes.

Q. 47. 98.13 for the third quarter of 1916?

A. Yes.

Q. 48. 98.65 for October, 1916?

A. Yes.

Q. 49. 96.84 for the three days in November, 1916?

A. Yes.

Q. 50. Proceed?

A. The tonnage of tailings was simply taken by the difference between the tonnage of headings and the tonnage of concentrate.

Q. 51. By simple subtraction?

A. By simple subtraction. In the same way the contents of the tailings expressed in pounds of copper are taken by subtraction.

Q. 52. Subtracting the total copper in the concentrate from the total copper in the feed?

A. Yes.

Q. 53. Proceed.

A. The assay of the tailings has then been calculated by dividing the contents of the tailing by the tonnage of the tailing.

Q. 54. That figure is found in the first column under the heading assay per cent copper and the column that is headed calculated by contents, is it?

A. Yes.

Q. 55. And is .175 for the third quarter of 1916?

A. Yes.

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Q. 56. .149 for October, 1916?

A. Yes.

Q. 57. And .489 for these three days in November, 1916?

A. Yes.

Q. 58. What is the next column?

A. The next column is their given assay.

Q. 59. Given in exhibit 29?

A. Given in exhibit 29.

Q. 60. Where that differs if at all, from the calculated assay, which is the one likely to represent the actual fact?

A. Over any continued period of operation the first column will represent more accurately the actual facts.

Q. 61. Proceed.

A. The next two columns "Loss of Copper in Tailings per Ton of Heading," that is to say, I divided the tons of tailing—the pounds of copper by the tons of heading to flotation.

Q. 62. And that figure indicates that for every ton of ore going into the feed at the head of the flotation mill, 2.62 lbs. of copper ran to waste at the foot of the mill?

A. Yes.

Q. 63. And that figure was 2.62 for the first quarter of 1916, 2.10 for October, 1916, and 6.47 for the three days of November?

A. Yes.

Q. 64. Proceed.

A. In the next column I have given the value of

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the copper in the tailings, reckoned per ton of heading, as if every pound of copper recovered in the form of a concentrate would be worth twenty cents net to the mill, which it would be if the market price were thirty cents.

Q. 65. That is figured by simply multiplying the pounds lost, as indicated by the first column, by twenty cents?

A. Yes.

Q. 66. Proceed.

A. "The cost of smelting concentrates." In the case of Mr. Englemann's evidence concerning ~~the Ray~~ mill, he said that the cost of treating ~~their~~ the Chino concentrates was $5.00 per ton.

Q. 67. A flat rate?

A. A flat rate. In their case the mill is very close to the smelting plant. I have taken that figure of $5.00 as being the likely cost of smelting their concentrates in El Paso, added $1.00 for freight from the Chino mill to El Paso.

Q. 68. That is from the Chino mill to the El Paso smelter?

A. Yes.

Q. 69. That is a fair freight rate, is it?

A. I think so.

Q. 70. And $5.00 was a fair smelting charge?

A. Yes.

Q. 71. You assume that same figure in all three cases?

A. Yes.

James Wilding.

Q. 72. Proceed.

A. Then I multiplied the tons of concentrates produced by $6.00, giving the total smelting charge in that period of the concentrate produced. I divide that figure by the tons of heading to flotation, and obtained the cost of smelting the concentrate per ton of heading to flotation.

Q. 73. That appears in the third column of the columns headed "Cost of Smelting Concentrate"?

A. Yes.

Q. 74. Proceed.

A. In the total cost of concentration I have taken as the operating cost the letter "a," the cost being unknown to me, I then figured the total cost of the operation per ton of heading, and I have added to "a" the value of the copper per ton of heading lost in the tailing and the smelting cost of the concentrate per ton of heading.

Q. 75. In each case?

A. In each case.

Q. 76. For example in the first case the cost per ton of heading, including the loss in tailing and cost of smelting would be this factor "a"—

A. "a"—plus $2.047.

Q. 77. Plus .524, representing the loss of copper in the tailing, per ton of heading, plus 1.523, representing the cost of smelting per ton of heading; total the milling cost—"a" plus $2.047. That is what that means, is it?

A. Yes.

James Wilding.

Q. 78. And the same way with the other periods?

A. Yes.

Q. 79. In the case of the third item, what is the notation, "A plus 15 for extra oil, etc," What is the 15?

A. I imagine—Pardon me; I won't put it that way—I think it is certain that they used extra oil will result in adding about 15 cents per ton to the cost compared to that in ordinary operations.

Q. 80. 15 cents per ton of original feed of ore?

A. Yes.

Q. 81. Taking the cost of the extra oil at that figure, 15 cents, you get for that period as a total cost, the figure "a" plus 3.476 for the cost of concentration per ton of ore fed to the mill?

A. Yes.

Q. 82. Now, proceed.

A. The difference is in favor of the periods during which the smaller amount of oil was used.

Q. 83. The notations in the last two columns of the oils and other reagents were obtained from what source?

A. From exhibit No. 29.

Q. 84. Now, what is your conclusion based upon these figures and this comparison?

A. That during the period of working with small quantities of oil they actually made better profit than during the later period. It will not show in this case, because the heading to flotation for November 18th, 19th and 20th contained over 10% copper,

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whereas in the other periods it was between seven and eight per cent.

Q. 85. But even with that difference in the heading the cost of concentration during those three days, as determined by Mr. Wicks' figures, as compared with the third quarter of 1916 was greater by $1.43 or thereabouts?

A. Yes.

Q. 86. For every ton of ore that went into the mill?

A. Yes.

Q. 87. And the cost of concentration during those three days, as determined by Mr. Wicks' figures, as compared with the cost during the month of October, 1916, was the difference between 3.467 and 2.187?

A. Yes.

Q. 88. That is to say, $1.29 or thereabouts, per ton of original ore fed to the head of the flotation plant?

A. Yes.

Q. 89. You have expressed the opinion, I believe, judging from those results, that the efficiency during the third quarter of 1916 and during the month of October, 1916, instead of being poorer than during those three days in November, was better?

A. Yes.

Q. 90. Notably better?

A. No, not notably better.

Q. 91. But better?

A. Better.

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Q. 92. Now, Mr. Englemann of the Hayden plant of the Ray Copper Company, comparing his own figures, given in Exhibit No. 150, for the year 1916, in retreating vanner concentrate products (when, as he says 3.36 lbs. of oil were used per ton of ore). With the figures that he gives for the first three months of 191~~6~~7 (when, as he says, 20.1 lbs. of oil were used) seems to say, in answer to Q. 32 to Q. 35, that the latter were the better, that is to say, with 20.1 pounds of oil. ~~One~~ and he figures out theoretically 17 pounds more of copper produced in 1917 per ton of ore than in 1916. This, however, he seems to take back in the answer to Q. 84, saying that that figur~~e~~ing does not really mean anything, if I understand him correctly, and he substitutes some other method of comparison by tonnage and assay of feed, concentrate and tailings, from which he figures the amount of copper running to waste in the tailings per ton of ore fed, and so compared, he finds the two periods practically the same, and he leaves it there. Now, if you are able to do so from the figures given by Mr. Englemann on exhibit 150, please compare the first quarter of 1917 with an equal period in 1916, and with a period in 1916 when the other mill conditions were presumably nearest to those of 1917—namely, the last quarter of 1916; and state how the results compare metallurgically, not only in respect to the relative amount of copper going to waste in the tailings, but also with respect to all other matters (omitted by Mr. Engel-

mann,) that would be considered and would have to be considered in practice. Have you prepared a table that will show these conclusions?

A. I have prepared a table comparing the results of the fourth quarter of 1916 with those of the first quarter of 1917.

Table offered in evidence by plaintiff admitted marked PLAINTIFF'S EXHIBIT No. 256.

Q. 93. Will you now please explain this table as you did the other?

A. From Exhibit 150 I have taken the weight of headings to flotation and its assay, and the weight of flotation concentrates produced and its assay and calculated in each case the copper contents as before.

Q. 94. For example, the copper contents of the heading to flotation in the last quarter of 1916 was 3,327,005 pounds?

A. Yes.

Q. 95. And the copper contents of the flotation concentrate for that same quarter was 3,210,974 pounds?

A. Yes.

Q. 96. Now, proceed.

A. I have then calculated the copper recovery in the concentrate expressed as to per cent by dividing the copper contents of the concentrate by the copper content of the heading.

Q. 97. That gives you for the last quarter of 1916

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a calculated recovery of 96.51 per cent of the copper?

A. Yes.

Q. 98. And for the first quarter of 1917 a calculated recovery of 95.12 per cent of the copper?

A. Yes.

Q. 99. You passed the column headed "rate of concentration." What about that?

A. The ratio ~~rate~~ of concentration it should be.

Q. 100. It should be ratio, should it?

A. The weight of heading to flotation divided by the weight ~~contents~~ of concentrates produced.

Q. 101. Should that word be "ratio"?

A. Ratio.

Q. 102. Now, proceed. The second column under the heading "recovery"?

A. Is the figure given in exhibit 150.

Q. 103. And, before I proceed on this question. the figure given in the column "calculated" is the actual copper realized as a result of the whole operation, realized in the concentrate out of the copper in the feed?

A. Yes.

Q. 104. Now, proceed with the tailing?

A. The tailings, first column is the total of tailings.

Q. 105. How obtained?

A. By subtraction of the tonnage of concentrates from tonnage of headings. The contents of the tailing in pounds of copper is also taken by the difference

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between the contents of the heading and the contents of the concentrate.

Q. 106. And represents the actual copper of the headings that was not found in the concentrates?

A. Yes.

Q. 107. Proceed.

A. The copper assay is then calculated by dividing the contents in copper by the tonnage of the tailing.

Q. 108. That figure "calculated assay of copper" is the actual copper in pounds not accounted for in the concentrate, divided by the tonnage of the tailings?

A. Yes.

Q. 109. And the next column?

A. And the next column is the assay given in exhibit 150.

Q. 110. Proceed.

A. The loss of copper in tailings per ton of heading. That is calculated by dividing the contents of the tailing by the tonnage of the heading.

Q. 111. That is to say dividing the contents in pounds of copper of the tailing, 116,031 pounds in the first period, by the tonnage of the headings?

A. Yes.

Q. 112. That figure shows for the last quarter of 1916 a loss of 4.25 pounds of copper in the tailings for every ton of ore fed to the flotation plant?

A. Yes.

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Q. 113. And during the first quarter of 1917 a loss of 6.37 pounds of copper for every ton of ore fed to the flotation plant?

A. Yes.

Q. 114. Proceed.

A. The value of that copper lost in the tailings per ton of headings is then calculated at a price of twenty cents.

Q. 115. Net at the mill?

A. Yes.

Q. 116. Giving for the first period eighty-five cents per ton of headings and for the second period 1.27 per ton of headings?

A. Yes.

Q. 117. Proceed?

A. Cost of smelting concentrate. The smelting charge of $5.00 per ton of concentrate was given by Mr. Englemann.

Q. 118. You make no allowance here for freight?

A. No.

Q. 119. Why is that?

A. Well, they are near to the smelting plant.

Q. Proceed.

A. The total is arrived at by multiplying the tonnage of the concentrate by five dollars, and working back to tons of heading, dividing by the tons of the same, so that the cost of smelting the concentrates for the first of the two periods in question was during the last quarter of 1916 $1.12 per ton of heading.

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A. $1.37.

Q. 122. Proceed.

A. Then I have taken as a milling cost, "a" and added the value of the copper lost in the tailing.

Q. 123. In the first case, eighty-five cents per ton of heading?

A. And then the cost per ton of the headings of ~~to~~ smelting the concentrates produced.

Q. 124. In the first case $1.12 per ton of headings?

A. Yes.

Q. 125. And what about the entry fifteen cents for extra oil in the second period?

A. I think that is what it would cost them extra, pursuing that method of operation.

Q. 126. This method of calculation, gives as the cost of concentration during the last quarter of 1916 the milling cost, whatever that is, plus $1.97 per ton of heading, and for the first quarter of 1917 that same milling cost plus $2.79 per ton of heading. That is correct, isn't it?

A. Yes.

Q. 127. So that the difference in cost of concentration is eighty-two cents?

A. Yes.

Q. 128. Per ton of ore fed to the flotation plant?

A. Yes.

Q. 129. And was that much greater during the first three months of 1917 than during the last three of 1916?

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A. That was greater.

Q. 130. Where did you get the items under the heading "oil pounds per ton of heading"?

A. From exhibit 150.

Q. 131. What is your conclusion then, from this comparison?

A. That the period of the fourth quarter of 1916 was more successfully, metallurgically, than the period of the first quarter of 1917.

Q. 132. There is a legend, a note at the bottom of this exhibit 256. Will you please explain that?

A. On account of the lower grade of concentrate produced, it must contain, if it is produced from similar feed, a greater amount of gangue and that would make in smelting a larger amount of slag, which would carry additional copper off.

Q. 133. So that in addition to the greater loss of copper in the concentrating operation itself, there would be a greater loss of copper in the smelting operation?

A. Yes.

Q. 134. And the difference in grade of concentrate to which you refer is shown on this table under the heading "flotation concentrate, assay copper" and is in the last quarter of 1916 26.38, and in the first quarter of 1917 22.76, is it?

A. Yes.

Q. 135. These figures being taken from exhibit 150?

A. Yes.

MR. KENYON: Plaintiff's counsel offers in evi-

dence the sworn statement of the Butte & Superior Copper Company, Limited, for the month of January, 1916, filed pursuant to order of court, entered in the above entitled action on November 15th, 1913, and now of record in this case, in this court, and similarly the similar and successive monthly statements from that report down to and including the report of March, 1917.

MR. KREMER: May I inquire the purpose? Perhaps I want to object.

MR. KENYON: To give the basis of the figures the witness is about to present comparing the procedure of the defendant in the year 1916 with its procedure in the year 1917, as to the results, how they correspond.

MR. KREMER: Has it to do with the operation itself or is it introduced purely for the purpose of making a financial comparison?

MR. KENYON: Just a comparison.

MR. KREMER: Financial or otherwise?

MR. KENYON: No, not financial, metallurgical, the same sort of metallurgical comparison we have been making in the other two plants.

MR. KREMER: We have no objection.

Statements admitted in evidence and marked PLAINTIFF'S EXHIBITS 257 to 271 inclusive.

Q. 136. MR. KENYON: Please compare metallurgically the oil flotation achieved by the Butte &

Superior Mining Company, defendant, during the last quarter of 1916 as shown in certain monthly statements on file, being exhibits 266, 267 and 268, when considerably under three pounds of oil per ton of feed was used, as shown in exhibit 158, with the first quarter of 1917 as shown in such monthly reports, being exhibits 269, 270 and 271, when about twenty pounds of oil was used, as appears on exhibits 159. 161 and 162, and if you have prepared a statement for that purpose, will you please produce it?

A. I have here a statement comparing the results of the last quarter of 1916 with those of the first quarter of 1917.

MR. KENYON: The plaintiff offers the tabulation produced by the witness in evidence.

Tabulation admitted in evidence and marked

PLAINTIFF'S EXHIBIT 272.

Q. 137. Will you please now explain this exhibit 272?

A. The monthly statements from which the figures are taken, give the tons of ore delivered to the flotation plant.

Q. 138. This appears in the first column, does it?

A. Yes. The assay of the same.

Q. 139. That appears in the second column?

A. Yes.

Q. 140. Assay in zinc?

A. Yes. The tons of concentrate produced.

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Q. 141. That appears in the first column under the heading "concentrates" does it?

A. Yes. The assay of the same.

Q. 142. The assay per cent of zinc?

A. Yes.

Q. 143. That appears in the second column under the heading "concentrates," does it?

A. Yes.

Q. 144. Please proceed.

A. The cost of flotation per ton of concentrate produced.

Q. 145. Where is that found?

A. That is found in the last column of the tabulation.

Q. 146. Proceed with your description of the table?

A. I have calculated from these figures the contents of zinc in the heading.

Q. 147. And this content in tons is found in the third column under the heading "ore delivered to plant"?

A. Yes. The zinc contents tons of the concentrates.

Q. 148. These appear in the third column under the heading, "Concentrate," and are in tons, are they?

A. Yes, they are. The recovery of zinc in the concentrate.

Q. 149. How about that figure?

A. By dividing the contents of the concentrate by the contents of the heading.

Q. 150. That is to say that figure for October, 1916, being 93.582 means that the total tons of zinc

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contained—total tons of zinc content of the concentrate for that month, namely 7,579.98 tons was that percentage of the total zinc content of the ore delivered to the plant during that month, namely 8,099.83 tons?

A. Yes.

Q. 151. And so with each lower figure in this "recovery" column?

A. Yes.

Q. 152. Is that a proper way to figure recovery?

A. Yes.

Q. 153. Is that the best way to figure recovery?

A. Over any continued period of operation.

Q. 154. Being the copper actually recovered by the whole process compared with the copper that went into the operation at the head of the mill?

A. Yes.

Q. 155. Before we leave the matter of recovery. The last quarter of 1916 shows according to your figures a recovery of 92.941 per cent, and the first quarter of 1917 shows a recovery of 83.110 per cent, does it?

A. Yes.

Q. 156. And before we leave it, the grade of the concentrate, the average grade of the concentrate produced during the last quarter of 1916 was 53.254 per cent in zinc?

A. Yes.

Q. 157. And for the first quarter of 1917 was 47.228 per cent in zinc?

A. Yes.

Q. 158. Now, proceed.

A. The tons of tailings going to waste are taken by subtracting the tons of concentrate produced from the tons of heading. The contents of the tailings in zinc is also taken by the difference between the contents of the concentrate and the contents of the heading.

Q. 159. You subtract the total zinc content in the concentrate from the total zinc content in the ~~tons of~~ heading?

A. Yes.

Q. 160. And that tonnage of zinc must have gone to waste?

A. Yes. I then calculated the pounds of zinc going to waste in the tailings per ton of heading delivered to the plant.

Q. 161. Calculated that in what way?

A. By dividing the pounds of zinc in the tailing by the tons of ore in the heading.

Q. 162. That computation shows that in the last quarter of 1916 for every ton of ore fed to the flotation plant 19.11 pounds of zinc ran to waste in the tailing and that for the first quarter of 1917 for every ton of ore fed to the head of the flotation plant 43.22 pounds of zinc ran to waste in the tailings, does it?

A. Yes. I have then calculated the amount of zinc in the tailings by dividing the zinc contents by the tons of the tailings.

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Q. 163. That shows for the last quarter of 1916 that the tailings assayed 1.24 per cent of zinc, and for the first quarter of 1917 that the tailings assayed 2.789 per cent of zinc, does it?

A. Yes. I have given the zinc assay which is given in these sworn statements in the other column for the sake of comparison.

Q. 164. Now, as to the last three columns under the heading "costs"?

A. The sworn statementS give~~s~~ costs of the operation per ton of concentrate produced. This multiplied by the tons of concentrate gives the total cost. That divided by tons of heading gives the cost per ton of heading.

Q. 165. So that in the last column you have the figure which is given in these sworn monthly statements of the cost per ton of concentrate?

A. Per ton of concentrate produced.

Q. 16~~5~~6. Multiplying that figure by the number of tons of concentrate produced in that interval, which is also given in the statement, is it?

A. Yes.

Q. 167. And you get the total which appears in the first of the last three columns?

A. Yes.

Q. 168. Then you divide that total by the total tonnage that was delivered to the plant during that interval as also appears in the monthly statements?

A. Yes.

James Wilding.

Q. 169. And you then get the final figure in the middle of these last three columns, the cost per ton of ore delivered to the plant?

A. Yes.

Q. 170. That calculation shows that during the last quarter of 1916 that cost was a little over eighty-two cents per ton of ore delivered to the plant?

A. Yes.

Q. 171. And for the first quarter of 1917 that cost was $1.34 per ton of ore delivered to the plant?

A. Yes.

Q. 172. What is your conclusion as to the comparative efficiency or merit of the operation during these two periods?

A. That the operations for the first quarter of 1917 were very much less successful than those for the last quarter of 1916.

Q. 173. I notice some difference in the grade of the ore delivered to the plant from month to month. Does that introduce some differences, or may it introduce some differences?

A. Yes.

Q. 174. Now, in order to eliminate that as much as possible, I will ask you to compare the month of March, 1917 with the month of January, 1916, as both are shown in these monthly reports, March, 1917, being Exhibit 271 and January, 1916, being Exhibit 257, and I have selected those two months because they are most nearly alike in the grade of the headings, in the grade of the feed; also similarly, February 1917 with June 1916 being exhibit 270 with exhibit

262, those two months being very similar in the grade of the feed and the third, January, 1917, with November, 1916, being exhibits 269 with exhibit 267, and also for the same reason, the grade being very similar in those months. If you have prepared a table?

A. I have.

Q. 175. Please produce it.

A. (Table produced.)

MR. KENYON: Plaintiff's counsel offers the paper produced by the witness in evidence.

Said table admitted in evidence marked

PLAINTIFF'S EXHIBIT No. 273.

Q. 176. Will you please now explain this table and the different legends on it?

A. I have taken from the statements of the manager of the Butte & Superior Company, monthly statements,—the tons and assays of the ore delivered to flotation plant, and the tons and assay of concentrates produced, the cost per ton of concentrate produced; I have then calculated the value of the concentrates produced in each of these months by assuming certain terms of sale with a market price for the spelter at $9.50 per 100 lbs. The formula adopted for the sake of this comparison, in these conditions and the sale terms, are given below in appendix No. "A" with an example of working out the value.

Q. 177. You may explain that later. That elimin-

ates the differences in the price from time to time. does it?

A. That is the way it is figured.

Q. 178. And it gives a comparison of the metallurgical results obtained?

A. Translated into dollars.

Q. 179. The first two columns, tons and assay of zinc, you obtained from the monthly statements, I understand?

A. Yes.

Q. 180. The third column you figured how?

A. By multiplying the tons of heading to flotation by the assay.

Q. 181. Giving the total tons of zinc contents of the heading to flotation?

A. Yes.

Q. 182. The same way with the concentrates?

A. Yes.

Q. 183. The third column there you have figured in the same way?

A. Yes.

Q. 184. And as to the recovery, how have you figured the recovery of zinc by contents?

A. The recovery is the ratio of the contents of the concentrates to the contents of the heading, in zinc, expressed in percentage.

Q. 185. The actual zinc that was recovered, the percentage of that to the actual zinc which went in with the heading?

A. Yes.

James Wilding.

Q. 186. That figure, then, is the actual recovery, even though a calculated figure?

A. Yes.

Q. 187. And that figure in the first of the three comparisons called for shows in January, 1916, 93.117?

A. Yes.

Q. 188. As contrasted with March, 1917, 85.228?

A. Yes.

Q. 189. A difference of 7.889 in favor of January, 1916?

A. Yes.

Q. 190. And for the second comparison it shows that June 1916 was 93.972; for February, 1917, 81.155, a difference in favor of June, 1916, of 12.817%, does it?

A. Yes.

Q. 191. And as to the third comparison, for November, 1916, it shows 92.929, and for January, 1917, 82.858, a difference in favor of November, 1916, of 10.071%, does it?

A. Yes.

Q. 192. And just before you leave that, the grade of the heading in the two months first compared, January 1916, and March, 1917, are very close, are they, 12.496 in one case and 12.489 in the other; that is close, is it?

A. Very near.

Q. 193. And the second two months compared, show, June, 1916, 12.976 grade of heading and February 1917, 12,988. That is close, is it?

A. Yes.

Q. 194. And in the third comparison, November, 1916 shows 13.001 and January, 1917, 12.923 grade of heading; that is close, is it?

A. Yes.

Q. 195. That was the reason these months were selected, was it?

A. The only reason.

Q. 196. Now proceed to the tailings.

A. Under the heading "Tailings" I have calculated the weight of the tailing going to waste by the difference between the weight of concentrates produced and the weight of heading, in the same way I have calculated the contents of the tailings in zinc.

Q. 197. The third column, under the heading "Tailings" shows the pounds of zinc running to waste for every ton of ore fed to the flotation plant, does it?

A. Yes.

Q. 198. Pausing to compare them a moment, in January, 1916, 19.23 lbs. of zinc went to waste in the tailings for every ton of ore treated?

A. Yes.

Q. 199. In March 1917, 36.90 lbs. of zinc was run to waste?

A. Yes.

Q. 200. Showing a difference of 15.67 lbs. of zinc in favor of the earlier period?

A. Yes.

Q. 201. In the second comparison, in June, 1916, 15.65 lbs. ran to waste and in February, 1917, 48.95

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lbs. ran to waste, showing a difference of 33.30 lbs. of zinc per ton of heading in favor of the earlier period?

A. Yes.

Q. 202. And with respect to the third comparison, November, 1916, showed 18.39 lbs. of zinc running to waste, and January, 1917 showed 44.30 lbs. of zinc running to waste, with a difference of 25.91 lbs. of zinc per ton of heading in favor of the earlier period?

A. Yes.

Q. 203. Now, proceed to the next column and explain the heading "Assay ~~of~~ % Zinc" and "Calculated by Contents."

A. To arrive at the tailings assay of zinc I divided the contents of the tailings by the tonnage of the same.

Q. 204. That calculation shows, in the case of the first comparison, in January, 1916, 1.093% of zinc running to waste, the tailings containing 1.093% of zinc running to waste, and in March, 1917, the tailing containing 2.382% of zinc running to waste, with a difference of 1.289% in favor of the earlier period?

A. Yes.

Q. 205. And in the second comparison, January, 1916, shows 1.007% tailings; February 1917 shows tailings containing 3.183% zinc, with a difference in favor of the earlier period of 2.175% zinc?

A. Yes.

Q. 206. Third comparison, November, 1916, shows 1.187% zinc, January, 1917, 2.838% zinc, with a difference of 1.651% in favor of the earlier period?

A. Yes.

Q. 207. What are the figures in the column given under "Assay % Zinc"?

A. They are given in the statements.

Q. 208. Under the headings "Oils and Acids per Ton of Heading"?

A. Those are taken from exhibit No. 158.

Q. 209. And are approximate?

A. Approximate.

Q. 210. Now, explain under the heading "Cost" what figure is given in the monthly statements.

A. As to cost, the statement gives the cost per ton of concentrate produced.

Q. 211. That is the middle column?

A. That is the middle column. By multiplying the tons of concentrates produced by that figure you get the total cost.

Q. 212. In the third column?

A. Third column. By dividing the total cost by the tons of heading to flotation you get the cost per ton of heading.

Q. 213. You get the first column?

A. Yes.

Q. 214. Now, that total cost per ton of heading in the case of the first comparison, January, 1916, and March, 1917, showed a difference of over 70 cents per ton of heading in favor of the earlier period?

A. Yes.

Q. 215. And the second comparison, June, 1916,

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and February, 1917, showed a difference of 56 cents a ton of heading in favor of the earlier period?

A. Yes.

Q. 216. And in the case of the third comparison, November, 1916, with January, 1917, there was a difference of 56—nearly 57 cents in the total cost in favor of the earlier period?

A. Yes.

Q. 217. Now, explain the next three columns.

A. To arrive at the value per ton of zinc concentrates produced we have assumed or taken a set of sales conditions.

Q. 218. Shown in Appendix A?

A. Shown in appendix A.

Q. 219. A fixed set for all periods?

A. The same for all periods.

Q. 220. And are those fair conditions that you have there assumed?

A. I think they are fair for the whole period covered.

Q. 221. Please explain them.

A. The market price of zinc during 1916—the average market price was over 12 cents. We have assumed 9½, because 1917 comes under a period of lower spelter prices.

Q. 222. That is, your first item which says "Assumed Market Quotation for Spelter, $9.50 per hundred pounds, being below the average for the period in question," that is what you have just explained, is it?

A. Yes.

Q. 223. Now, proceed.

A. An example is then given.

Q. 224. Explain the next item, for one ton of concentrates of 45% zinc.

A. The base price is taken at $21.00 for 45% zinc.

Q. 225. That is a usual contract price is it?

A. Yes.

Q. 226. Now, explain the next item.

A. On each rise or fall of the market quotation one dollar above the base quotation, $5.00 per 100 lbs. above or below, $6.00 is added to or taken from the base price per ton of concentrates.

Q. 227. For each $1.00 rise above $5.00 there is $6.00 per ton of concentrate added to the value of the concentrate?

A. Yes.

Q. 228. What is the next item?

A. For each unit of zinc assay in the concentrate above 45% we have added 90 cents per ton to the concentrates.

Q. 229. That is an added value of the concentrate for each per cent of grade above 45%?

A. Yes.

Q. 230. And does that represent fair market conditions?

A. Yes.

Q. 231. What is the last item?

A. Allowed to cover the cost of freight to market

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and loading and freight on the moisture in the concentrates, $8.00.

Q. 232. Now, will you explain this example in which that formula is applied?

A. I have taken the concentrate of January 16th, 54.59% zinc. The base price for concentrate of 45% zinc is $21.00. Bonus for increase in grade would be 9.59 units at 90 cents, $8.63.

Q. 233. That feature of increase of grade would add to the value of each ton of concentrates $8.63?

A. Yes. Bonus for increase in market price, 4.5 units at $6.00, $27.00.

Q. 234. The total is $56.53?

A. Yes. From this total has been deducted $8.00, as shown in the formula.

Q. 235. Leaving $48.63?

A. As the net value at the mill of one ton of concentrates.

Q. 236. And where have you entered that figure?

A. In the middle column under the heading "Sales Value of Concentrates on Equal Terms as Shown in Appendix A."

Q. 237. Zinc only, what does that mean?

A. There is no silver being taken into account or the gold in the concentrate.

Q. 238. That would add to the value?

A. It would add to the value.

Q. 239. And so for each of the six figures in that middle column, $48.63 for January, 1916, you have

calculated it out in the same way and according to that same rule?

A. Yes.

Q. 240. That shows that as between January, 1916, and March, 1917, each ton of concentrate was worth $6.64 more in the earlier period, does it?

A. Yes.

Q. 241. And as between June, 1916 and February, 1917, each ton of concentrate was worth $8.04 more in the earlier period?

A. Yes.

Q. 242. And as between November, 1916 and January, 1917, each ton of concentrate was worth $4.23 more in the earlier period?

A. Yes.

Q. 243. Now proceed.

A. By multiplying the tons of concentrates produced by the sales value per ton, we have a total sales value of concentrates produced.

Q. 244. Which you show in the last of those three columns under the heading, "Sales Value"?

A. Yes.

Q. 245. Which shows a difference in the case of the first comparison of $65,417.00 in favor of the earlier period. In the case of the second comparison $121,526.00 in favor of the earlier period, and in the case of the third comparison $104,599.00 in favor of the earlier period, does it?

A. Yes.

Q. 246. Now, how do you get the first column?

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A. The first column is arrived at by dividing the total sales value by the tonnage of heading to flotation.

Q. 247. Which shows in the case of the first comparison a difference of 89 cents in favor of the first period?

A. Yes.

Q. 248. And $1.49 in the second comparison in favor of the earlier period?

A. Yes.

Q. 249. And $1.23 in favor of the first period in the third comparison?

A. Yes.

Q. 250. Now, the last two columns headed "Profit".

A. The profit is arrived at by subtracting from the sales value per ton of heading the cost per ton of heading, and in the same way per ton of concentrate produced.

Q. 251. Subtracting this cost per ton of heading from the sales value per ton of heading, you get the ultimate profit per ton of heading, do you?

A. Yes.

Q. 252. And in the case of the first comparison, that shows an advantage of $1.60 per ton of heading in favor of the earlier period over the later?

A. Yes.

Q. 253. And in the case of the second comparison a profit of $2.05 per ton of heading in the earlier period over the later?

A. Yes.

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Q. 254. And in the case of the third comparison a profit of $1.81 per ton of heading in favor of the earlier period over the later?

A. Yes.

Q. 255. And the last column is what?

A. The last column is the profit realized per ton of concentrate produced, arrived at in the same way.

Q. 256. Now, what is the note above Appendix A; will you explain that?

A. The figures indicate that the modification of operating with excess of oil would cause a decrease of profit from the zinc alone of about $1.75 per ton of ore delivered to the flotation plant. The tonnage figure seems to me to imply that it would be necessary to provide more equipment in the mill to get the same capacity as it had under the older mode of operation.

Q. 257. The figures indicate to you that the total tonnage capacity of the mill has been reduced?

A. Yes.

Q. 258. What else?

A. The silver loss is also somewhat greater, but I have not taken it into account; that is, the silver loss in the 1917 period. With the market price of spelter 9.50, the decreased profit on one year's heading to flotation, says: 580,000 tons, would be about $1,-015.000.

MR. KENYON: The witness is yours, Mr. Scott.

MR. SCOTT: I would like to cross examine the

witness for a moment to get at his method in some of these calculations and afterwards I would like to have an opportunity to check over all of these calculations before I complete it.

THE COURT: Yes.

CROSS EXAMINATION

BY MR. SCOTT:

X-Q. 259. Take the first, Mr. Wilding, your calculations and tabulation of the result at the Chino Copper Company on the vanner concentrate, exhibit 255, I would like to ask you first whether the ratio of concentration which you have adopted in this table does not depend on the usual formula, ratio of concentrate is equal to the assay of concentrate minus the assay of tails divided by the assay of heads minus the assay of tails?

A. This ratio of concentrate is the number of tons of heading that are necessary to produce one ton of concentrate.

X-Q. 260. My question is how you derive the figure, take 3.94 for the third quarter of 1916, my question is where you get the 3.94? You get it by the formula, do you not?

A. I get that by dividing 26,804 by 6,804.

X-Q. 261. You do that upon the presumption that 6,804, the tons of concentrate was an actual weight, did you not?

A. Yes.

X-Q. 262. You were not here when Mr. Wickes testified that 6,804 tons of concentrate was simply cal-

A. No, I was not.

X-Q. 263. And if the 6,804 tons, the figure for concentrate, was derived by the formula, then your calculation is fallacious is it not?

A. My calculations are based on the figures given.

X-Q. 264. But if the figure that is given was derived upon the formula?

A. I haven't calculated it in that method at all.

X-Q. 265. I know you haven't, but I say if the figure, tonnage of concentrate, was derived by the formula, then your method of using that tonnage to find the ratio of concentrate from, is based upon an error, is it not?

A. That tonnage must have been derived from the formula, then.

X-Q. 266. It was derived from the formula?

A. Then it should work back to the heading correctly.

X-Q. 267. That is the question. It was derived from the formula?

A. Well, now, if it was derived from the formula it should work back correctly to the heading in this way.

X-Q. 268. Well, that being the case, the ratio of concentration still does depend upon the formula because you start with a concentrate tonnage that depends upon the formula? Isn't that correct?

A. You start with a concentrate figure, yes; and the tonnage given for the concentrate.

X-Q. 269. Now, assuming that that flotation ton-

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nage was derived by the formula, then you simply work back to a ratio of concentrate which also depends on the formula?

A. If these ore weights are not given, they are calculated, and of course that depends upon the method he took for calculating.

X-Q. 270. Well, we will assume them to be correct, that that tonnage was—the concentrate tonnage was calculated upon the formula?

A. Yes.

X-Q. 271. The record will show it, but for the purpose of answering me you may assume that it is so?

A. Yes.

X-Q. 272. Now that being the case, this figure for the ratio of concentrate, 3.94, 3.4 and 2.94 for the three periods, all of them depend upon the formula which involves the assay of concentrate, the assay of tails and the assay of heads?

A. Yes.

X-Q. 273. Now, using tonnages based on this ratio of concentration, have you not calculated a value for the assay of the tailings?

A. Yes, of course. Everything depends on the weight of the concentrate and the weight of the heads.

X-Q. 274. And this being the case, the calculated assay of tailings which you have computed and inserted in this table does not agree with the actual assay?

A. No, it does not.

X-Q. 275. And with this information, that these

—that this flotation concentrate tonnage was calculated, you would not say, would you, that your figure for the assay of the tailings which does not check the number it started with, is more accurate than the original tailings assay?

A. There is evidently a very great discrepancy that seems to be due to imperfect work. If the tonnage concentrate calculated by any formula that you are to take is not that sum, not that amount, then it either cannot be correct or else the tailings assay cannot be correct, or some other assays. There must be some imperfection—some imperfect work somewhere, else these things would check.

X-Q. 276. Where is the error?

A. I cannot say where the imperfection was in the work.

X-Q. 277. Well, now, in view of this which do you think is the more accurate, your calculated assay of tailings derived as it is from three factors, one of which is the analytic assay figure itself, or that actual assay return?

A. I cannot express any actual opinion as to that. If the work was imperfect then I shall not say where the imperfection crept in and which is the more accurate assay.

X-Q. 278. I think you should be able to give me an opinion on this subject. We have here in this table the actual assay of tailings?

A. Yes.

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X-Q. 279. Taken by reliable sampling means?

A. Yes.

X-Q. 280. And assayed presumably by reliable assayers?

A. Yes.

X-Q. 281. And we have also figures—now, you have taken these actual assay figures in connection with other assay figures and have compiled another tailings assay. Now, can't you give me an opinion as to whether you think that by calculating, making a calculation based upon an actual assay and thereby calculating an assay, do you think your estimated, compiled assay is more accurate than the actual assay you started with?

A. Given these figures, if the given assay—if the given tailings assay is correct and the given heading is correct, then the given concentrate assay must be wrong.

X-Q. 282. I don't believe you have answered my question. My question is whether you think your calculated assay of tailings is more accurate than the assayer's own return?

A. Well, I say that if that is correct and the other assay which I presume is just as reliable as the tailings assay—

MR. KENYON: Indicating headings assay.

THE WITNESS: (Continuing)—then your concentrate assay must be wrong. There must be some error in the work in order to arrive at different results by the two methods.

(Question read as follows: "I don't believe you have answered my question. My question is whether you think your calculated assay of tailings is more accurate than the assayer's own return?")

MR. SCOTT: You must have an idea. That is susceptible of an answer.

A. The concentrate assays then is wrong or the headings assay is wrong.

X-Q. 283. I insist upon you answering the question?

A. I cannot express an opinion as regards the work. The figures show considerable discrepancy.

X-Q. 284. You mean to say then that having this assay figure, you intend to convey to me the idea that you do not know whether these calculated assays are more or less accurate than the actual assay you started with, to base your calculation on? You do not know?

A. Over a long period of time I would say that we have far more accurate results from samples of headings and concentrates than we have of tailings. Then, as a consequence, recoveries figured on the basis given, of calculations is more accurate than one calculated by the formula of assay to headings, concentrate and tails; and on that account, the only method of arriving at the amount of valuable material going away in the tails is by difference.

X-Q. 285. Is by what?

A. By difference of contents.

James Wilding.

X-Q. 286. Well, I do not think you have answered the question yet. My question was whether you think your computed assay of the tailings, which starts out with the real assay and utilizes it with two other assays, is more accurate than the actual assay returned to start with—actual assay returned you started with?

A. Well, then, we started with an assay of the heads that is wrong or an assay of the concentrate that is wrong.

X-Q. 287. You refuse to answer the question.

A. I think in the form in which you put it I am not called upon to express an opinion as to the accuracy of their work. Both cannot be true.

X-Q. 288. You think it is more accurate or you do not think it is more accurate, or you do not know anything about it?

THE COURT: The witness takes the three assays and says they cannot all be correct and has told you it is more likely the error is in the tailings assay than anywhere else for reasons that he gives. That comes pretty near answering it. Of course he does not give you a yes or no answer. He says there is bound to be an error there somewhere, because you cannot find your copper in these assays.

MR. SCOTT: Well, take your assumption that you think the greatest possibility of error is in the tailings assay as compared to the heads and concentrates, now, even making that presumption; do you think this calculation of yours will give you a more accurate figure than the tailings assay with which you started?

A. I can't quite see that, Mr. Scott.

(Question read.)

A. It will give me an accurate figure for recovery, but not necessarily more accurate than the other. As I say I cannot express an opinion as to the accuracy of the work.

X-Q. 289. Is there any other possibility of accounting for the difference that exists in your figures besides an error in assay?

A. Imperfection of work I say, not necessarily in assay.

X-Q. 290. In what work?

A. The work of sampling or weighing the heads or something or of assays.

X-Q. 291. Might be in any of those places.

A. Yes.

MR. SCOTT: For the present I would like to discontinue this cross examination and have an opportunity to go into these figures thoroughly before resuming it.

Witness excused.

M. W. ATWATER, recalled, testified as follows:

DIRECT EXAMINATION.

Q. 1. BY MR. WILLIAMS: Mr. Atwater, have you made a full calculation which Mr. Scott (Kremer) requested you to prepare and have you the figures of that calculation with you?

A. I have, and I have the figures with me.

Q. 2. Upon making that calculation what results did you obtain?

A. The total estimated increase in net profits would be $1,104,815.38.

MR. WILLIAMS: I think I will offer the calculation in evidence.

MR. SCOTT: I object to its admission in evidence on the ground that it is incompetent, irrelevant and immaterial, having no bearing upon any of the issues in the case.

MR. GARRISON: They asked for it, and we furnished it.

MR. WILLIAMS: The evidence is in. This is merely an explanation.

THE COURT: The evidence is in. This is merely a compilation. I do not know how much weight it is entitled to, if any, but it will be admitted, and the objection will be overruled.

Tabulation admitted in evidence and marked Plaintiff's Exhibit 274.

MR. WILLIAMS: The witness is offered for cross examination on this compilation.

MR. SCOTT: No cross examination.

Witness excused.

Eltoft Wray Wilkinson.

ELTOFT WRAY WILKINSON, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION.

Q. 1. By MR. KENYON: State your name, age, residence and occupation?

A. Eltoft Wray Wilkinson, 30 years old, metallurgist and engineer.

Q. 2. Residence?

A. San Francisco is my principal residence.

Q. 3. What has been your education and training in metallurgical directions?

A. In metallurgical directions I have had no training except the last seven years with the Minerals Separation. My previous education was not in metallurgy at all. It was engineering work.

Q. 4. What was your engineering education?

A. I took a course in electrical and mechanical engineering at the University of Leeds.

Q. 5. In England?

A. In England. I graduated with honors in electrical engineering, taking mechanical engineering, physics and mathematics besides.

Q. 6. What has your experience been in metallurgical directions?

A. For the last seven years I have been employed by Minerals Separation both in England and United States, and also in Mexico to a certain extent ~~amount.~~ Dur-

Eltoft Wray Wilkinson.

ing that time I have been engaged in testing ores and investigating their treatment and starting up and running and installing flotation plants.

Q. 7. Laboratory work and field work?

A. Laboratory work and field work, both.

Q. 8. And handling all sorts of problems in connection with such installations?

A. Yes.

Q. 9. I wish you would compare the Butte & Superior Mining Company's figures for its oil flotation on zinc ore during the first quarter of 1917, as given in its sworn monthly reports, being Exhibits 269, 270, and 271, where approximately twenty pounds of oil was used per ton of ore with the Timber-Butte Mill figures for the same quarter for its oil flotation on the similar Elm Orlu ore, as given in plaintiff's Exhibit 249, and state which is the better, metallurgically, and why?

A. I have tabulated together the results of the first quarter of 1917.

Q. 10. And you produce a tabulated statement?

A. I have it here.

MR. KENYON: The plaintif offers the tabulated statement produced by the witness in evidence.

Statement admitted in evidence and marked Plaintiff's Exhibit 275.

Q. 11. Will you please explain this tabulation and interpret the results for us?

A. In the top set of figures, they are divided into two sets by a line in the middle; I have the Timber

Butte Mill results tabulated. In the lower set the Butte & Superior results.

Q. 12. From Exhibit 249?

A. Yes, from Exhibit 249. In the lower set I have the Butte & Superior mill results as taken from their sworn statements.

Q. 13. For the months of January, February and March, 1917?

A. Yes, sir. The second column shows the products, considered in the tabulation, the feed to flotation, flotation feed it is written here; flotation concentrate flotation tailings given and flotation tailings calculated. That is the same for both sets of figures. The third column shows the tons of material coming under these headings and the fourth column shows those same tonnages reduced to the basis of 100 tons flotation feed for comparative purposes, so that we can compare them for an equal amount of feed.

Q. 14. In the case of the Timber Butte Mill the concentrate is a little over 25 per cent of the total weight of the flotation feed?

A. 25.643 per cent.

Q. 15. And the tailings are a little under 75 per cent?

A. Yes, sir.

Q. 16. And in the other case?

A. 22.514 per cent is the weight of the concentrate.

Q. 17. As against?

A. Against the weight of feed.

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Q. 18. As against what for tailings?

A. 77.486.

Q. 19. That is simply a convenient way?

A. It is a convenient way of comparing these results, starting from a common basis. The next column is the assay of zinc, percentage of these products tabulated here showing that in the Timber Butte Mill the average feed assayed for the first quarter of 1917, 14.295 per cent zinc.

Q. 20. What was the Butte & Superior?

A. That was 12.793. The concentrate assay in the Timber Butte Mill was 54.474 per cent zinc as compared with 47.228 per cent of the Butte & Superior Mill and the tailings assay given for the Timber Butte Mill was 0.714 per cent zinc as against 2.192 per cent of zinc given for the Butte & Superior Mill. That is calculated from the figures of each of these months, the weight of tailings and the assay of tailings presumably multiplied together and added and averaged.

Q. 21. When you say "given" that means that the figures are given in sources from which you have taken them?

A. The sworn statements, yes.

Q. 22. Now, what is that last figure under the column "assay zinc per cent" that last figure in each case? "Tails calculated?"

A. I will be able to explain better that last figure after considering the next column I think.

Q. 23. All right, explain it later then.

Eltoft Wray Wilkinson.

A. The next column shows the tons of zinc in the products obtained from these operations, assuming the operations to have been carried out on 100 tons of ore in each case. That is based on this percentage in the column of percentages. It shows that in the Timber Butte Mill in the feed ~~out~~ of 100 tons of feed there were fed 14.295 tons of zinc. In the concentrates there were recovered of this 13.969 tons of zinc, and in the tailings there were lost .0531 tons of zinc.

In the Butte & Superior Mill out of 12.793 tons of zinc fed in with 100 tons of flotation feed there were recovered in concentrates 10.632 tons of zinc and lost in the tailings according to the amount given 1.698 tons of zinc. Now, taking these figures we find that the sum of the tons of zinc in the concentrates and in the tailings adds up to not the same as the total tons of zinc in 100 tons of feed. And that might be due to an error in assaying or handling of samples or a number of errors might creep in there, and also it is harder to get a good assay on a low grade sample than it is on a high grade sample.

Q. 24. That is the tailings assays are harder to take accurately than the concentrate samples or the heading samples?

A. Or the heading samples, yes. The figures given as tailings calculated along the line starting "tailings calculation——"

THE WITNESS: On the line starting "Tailings Assay .326" is the difference between the tons of zinc

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in the concentrates and tons of zinc in the feed; in the first place 14.295, in the latter 13.969.

Q. 25. That is, assuming the accuracy of the assay of the feed as containing 14.295 tons of zinc, and the assay of the concentrate as containing 13.969 tons of zinc, there could have been only .326 tons of zinc in the tailing?

A. That is all there could have been.

Q. 26. That is all the zinc that was left?

A. Yes; the rest of the metal was in the concentrate. Now, the same way with the Butte & Superior figures I find, assuming the accuracy in the zinc assay of feed and concentrate, that the concentrates do not account for 2.161 tons of zinc, and as in mill operations there are two outlets for metal, the tailings and the concentrate, once it has got into the mill, we assume that it has gone into the tailings.

Q. 27. So that in that case if the Butte & Superior mill, as in the other case, if the assay of the flotation feed was correct, namely that 100 tons contained 12.793 tons of zinc, and if the assay of the concentrate was correct, that 100 tons of feed gave the concentrate 10.632 tons of zinc, then there were 2.161 tons of zinc unaccounted for, which must have been lost in the tailings?

A. Yes. Now, taking the defendant's figures for the tons of zinc in the tailings from the treatment of 100 tons of ore and distributing that figure—for instance, in the Timber Butte case, distributing that .326 tons of zinc through the 74.357 tons of tailings,

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it gives us an assay of .438%, which has been put down here as the calculated assay.

Q. 28. And in the case of the Butte & Superior the corresponding calculated assay of the tailings in the zinc would be what?

A. 2.789% of zinc calculated in the same way.

Q. 29. That is to say, if I understand you correctly, given the percentage of zinc stated in each case in the heading, and the percentage in the concentrate, and the tonnages given for those two, the tailings must have carried in the case of the Butte & Superior, 2.789% of zinc and in the case of the Timber Butte .438% of zinc.

A. They must. Now, the next column is the recovered per cent of zinc in flotation products, by flotation feed and concentrate; that is, assuming that the amount of zinc as determined by assay in the feed is correct and the amount of zinc in the concentrates is correct, taking into account the weight of concentrates produced, the per cent produced from the feed, we find that 97.72% of zinc in the case of the Timber Butte mill was recovered in the concentrate.

Q. 30. And the corresponding figure in the case of the Butte & Superior?

A. 83.11%. Now, the next figure, 3.7 there, stands for the recovery in the tailings, assuming the given assay figure to be correct.

Q. 31. You don't mean the recovery in the tailings; you mean the percentage in the tailings?

A. Well, the percentage of zinc in the tailings; it

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is lost, it is gone to waste, but it is figured in the same way as the recovery in the concentrates, and that is why I used the word. We find that 3.71% of the zinc went into the tailings.

Q. 32. Figured on the tailings assay?

A. Figured on the tailings assay as given. We also note that the addition of this 3.71, the percentage of zinc in the tailings, to the 97.72, the percentage of zinc in the concentrates, amounts to more than 100%.

Q. 33. It amounts to 101.43%?

A. Yes. That is merely confirmatory of what I said before as to the tons of zinc left in the tailings; it shows that if we take that tailings assay, .714, we again have more zinc than we actually had in the feed, which is impossible.

So the next figure, 2.28, shows the percentage of zinc lost in the tailings, figured on the calculated assay, .438% zinc, and that figure, plus 97.72, takes you up to 100%. In the same way on the Butte & Superior figures we find that according to their assay —that is, the assay computed form their figures—taking the tonnage of the tailings for each month and the assay given for that month—we find that 13.27% of zinc was carried away or lost in the tailings. I have already mentioned the recovery in the concentrates. These two ~~facts~~ foot up to 96.38.

Q. 34. They do not reach 100?

A. No.

Q. 35. Three or four per cent of the zinc is unaccounted for?

Eltoft Wray Wilkinson.

A. A little over 3½% is unaccounted for. The next figure, 16.89, is the percentage of zinc carried away in the tailings, assuming that that unaccounted for metal has gone into the tailings and was lost. There is no justification for thinking that it would go anywhere else, so we assume that it went into the tailings, as we did with the Timber Butte figures.

Q. 36. In the last column?

A. In the last column we have calculated—tabulated the percentage of recovery of zinc in the flotation products, the flotation concentrate and tailing; that is, we disregard the original feed assay and we assume that our concentrate assay and the tailing assay are correct, and assuming that these assays we have here are also correct, from the weights of the concentrates and the assay of the concentrates, and the assay of the tailings and the weights of the tailings we find the total amount of the metal present in the concentrates and tailings. Adding those up and proportioning them between the two products, we find that in the case of the Timber Butte mill 96.34% of zinc was recovered in the concentrates on that basis, and 3.64% was lost in the tailings.

Q. 37. And in the case of the Butte & Superior——

Q. 38. BY THE COURT: Where was the rest of it?

A. That foots ~~facts~~ up to 100%, or 99.98; that is simply a case of where the subsequent decimal figure here has been disregarded in tabulating these. In the case of the Butte & Superior figures, we find, figured

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on the same basis, that 86.23% of the zinc was recovered in the concentrates, and 13.77% was lost in the tailings.

Q. 39. Of those two methods of figuring the recovery, which, in your judgment is the more reliable and safer?

A. I would prefer the former method given in the last column but one.

Q. 40. That first method, as I understand you, takes the total zinc in the feed and compares it with the total zinc actually recovered in the concentrates, and charges off as loss the difference between the two?

A. What is not recovered in the concentrates is charged off as lost.

Q. 41. What is not recovered in the concentrates is gone?

A. Because the object of the process is to make concentrates out of a given amount of ore, and we judge our success by the amount of concentrates we make.

Q. 42. And since there must be an assay in each case, first of the feed, second of the concentrates, and third, of the tailings, which of those three are more likely to be correct and reliable, the first two and the calculation figured on the first two, or the second and third and the calculation figured on the second and third?

A. It is more likely to be accurate to figure on the first two than the second and third.

Q. 43. Now, what is your conclusion as to these

two operations, the one at the Timber Butte mill and the other at the Butte & Superior mill; which is the better metallurgically?

A. In my opinion the result obtained at the Timber Butte mill as shown in these figures is better considerably than the result obtained at the Butte & Superior mill, as shown by these figures.

Q. 44. Notably better, you would say?

A. I should say notably better.

Q. 45. The concentrate produced at the Timber Butte mill is of a grade of 54.474, is it?

A. Yes.

Q. 46. And the concentrate produced at the Butte & Superior mill is of a grade of 47.228?

A. Yes.

Q. 47. The recovery figured in the best way you know of, made at the Timber Butte mill, is 97.72, is it?

A. Yes.

Q. 48. And that at the Butte & Superior mill is 83.11?

A. Yes.

CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 49. Will you give it as a general statement, Mr. Wilkinson, that the accuracy of the sampling and assay results increases as the values in the sample increases?

A. Not as a general statement, no.

(Witness Excused.)

Parker C. McIlhiney.

PARKER C. McILHINEY, after being duly sworn as a witness for plaintiff, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Please state your name, age, residence and occupation?

A. My name is Parker C. McIlhiney; I am 46 years old; I reside in New York; my occupation is that of consulting chemist.

Q. 2. State briefly your education and qualifications.

A. I was educated at the School of Mines of Columbia University as a chemist, and after I graduated I remained for some post-graduate work, which led to a degree of doctor. Then I went into the practice of chemistry as a profession, and I have been in that practice since about 1895, with offices in New York. I gave, during my studies at college, special attention to the chemistry and to the technology of fats and oils, and have done considerable professional work in that line.

Q. 3. Did you do the analytical chemical work for the plaintiff in connection with the trial of the case of Minerals Separation, Limited, against Miami Copper Company?

A. I did.

Q. 4. Have you made chemical examinations and analyses of the specimens brought to you from Salt

Lake City by Prof. Fulton and party, marked as samples obtained at Utah Copper Company, Magna plant?

A. I have done so

Q. 5. I now show you plaintiff's exhibit No. 253, and ask you whether or not you made the determinations under the heading "Percentage Copper" in that table.

A. I did.

Q. 6. Are they or are they not accurate determinations of the copper percentages of the products examined by you?

A. I believe they are accurate.

Q. 7. I call your attention also to the figures in the column headed "Oil Upon Products." Did you make those determinations?

A. I did.

Q. 8. In your determinations you have as the first item, "Concentrates Vol." which I understand to be volatile, ".67%." Then, "Non-V" which I understand to be non-volatile "2.14%; total, 2.81%." Will you explain the meaning of that description of your results?

A. I described the results of the analyses that I made of these products in this way, giving separately the percentage of volatile oil and of non-volatile oil, simply because, in carrying out the determinations, I considered it safer and more accurate to determine first the volatile oil which was upon the samples, and having removed that, to proceed to the separate determination of the non-volatile portion. I simply reported these results in the form in which I obtained them.

Parker C. McIlhiney.

Q. 9. And where would the line be drawn as between volatile and non-volatile in view of the character of your determination?

A. That line would be drawn by counting as volatile oil the oil which could be removed from the product, ore or tailings or other products, by heating it in a current of steam to a temperature of about 130° C.

Q. 10. Now, have you made a comparison between the results obtained by you and the results reported by the Utah Copper Company, Arthur plant, and appearing in defendant's exhibit No. 251?

A. I have made such a comparison.

Q. 11. Now, in the determination that you have made as to the percentage of oil in the concentrates, your figure is 2.81%, is it not?

A. It is.

Q. 12. Now, what is the figure of the Utah Copper Company?

A. The figure which is reported by the Utah Copper Company is, as I understand it, the percentage of oil contained in the mixture of concentrate and oil. I have calculated my results in terms of the percentage by weight which the oil bears to the solid matter upon which it is carried, so as to make my report uniform throughout, both as to the amount of oil added to the ore in the feed, and as to the amount of oil found upon the products. I understand that this report is calculated the other way, but I have calculated from the figure given by the Utah Copper Company that,

on the same basis of the calculation that I used, the oil would be 2.40%.

Q. 13. That is to say, their figures "Combined Concentrate" which reads "Oil Analysis, Total Weight of Sample," and the figures "Total Weight of Oil Contained" and the figures, "Pounds of Oil per Ton, 46.88," you interpret as meaning that there is 46.88 pounds per ton, the total weight of the oil and solid matter?

A. I understand it so.

Q. 14. And making the correction or alteration to correspond to your method of computation, what percentage do you find?

A. 2.40%.

Q. 15. And what was your computation?

A. My result——

Q. 16. Your result, I mean.

A. My result as reported was 2.81.

Q. 17. Now, what is the next figure or determination of yours which you have just compared to the return of the Utah Copper Company?

A. The tailings.

Q. 18. In the Utah Copper Company report there is "No. 11 Tailing Sample, Cut No. 1—No. 11 Tailing Sample, Cut No. 2." Did you ascertain these separately or together?

A. No; I mixed the whole sample together and then examined it.

Q. 19. What was your determination as to the copper first?

Parker C. McIlhiney.

A. On the tailings I found .20% of copper.

Q. 20. And the report of the Utah Copper Company gives what for No. 1?

A. .165% copper.

Q. 21. And for No. 2?

A. For No. 2, .1~~4~~5 copper.

Q. 22. Now, are you satisfied of the accuracy of your determination?

A. I am satisfied that the assay that I made of the sample~~s~~ that I received is accurate.

Q. 23. And the discrepancy, is it or is it not larger than it ought to be for samples of the same product?

A. It is much larger than it should be for fairly taken samples of the same product.

Q. 24. Now, as to the oil determinations, can you resolve the figures of Utah with your method of determination?

A. I can, and when the calculation is made it shows that for the portion of the tailings sampled just described as Cut No. 1, where the report gives in pounds of oil per ton, 6.60—that corresponds by the method of description of the results which I have used to .33%; and in the case of Cut No. 2, the number of pounds of oil per ton reported there, which is 5.75, corresponds to .29%.

Q. 25. And what is your determination as to the total of the two cuts?

A. I find .199 per cent of oil on the tailings, the two samples having been mixed before examination.

Parker C. McIlhiney.

Q. 26. Here again is there or is there not a variation such as would not be ordinarily expected?

A. The variation is considerable and I think is larger than would be expected to occur between two similar analyses of exactly the same sample.

Q. 27. And, as to your determination, are you or are you not satisfied as to the accuracy of it?

A. I am quite satisfied that the oil determination that I made upon the sample that I received was accurate.

Q. 28. Now, what is the next comparison to make?

A. The skimmings of the first spitzkasten.

Q. 29. And that I take it is described as machine No 1 spitzkasten, No. 1 overflow in the Utah Copper Company report?

A. Yes. I understand that is the way they describe it in their report, the same material that I have described under the name of skimmings of first spitzkasten.

Q. 30. Now, make the comparison of their figures and yours?

A. As to the copper, the Utah Copper Company reports 19.1 per cent, whereas I have found 19.7 per cent. As to the oil, they report 412.31 pounds of oil per ton, and which calculated into the same shape as the results that I have, would be 25.97 per cent, and my figure refers—my figure for the same determination on the same material is 26.24 per cent.

Q. 31. The difference between these determinations

Parker C. McIlhiney.

as to copper and oil is not a large or unusual difference, is it?

A. Well, the difference in copper seems to me much more material than the difference in the oil.

Q. 32. Would you expect such a variation from a careful determination from the same character of material?

A. I think that samples of concentrates, if sampled perfectly accurately ought to agree more closely than these do in copper.

Q. 33. Now, what is the next figure, concentrate from the second spitzkasten?

A. Yes.

Q. 34. Please make a comparison of these?

A. On this product the Utah Copper Company reports a content of copper 21.25 per cent, whereas my result is 21.75 per cent. The amount of oil which they report, transformed into percentages on the basis that I have used, is 5.08, whereas I find in this product 4.97.

Q. 35. Were you one of the party representing the plaintiff which visited the plant of the Butte & Superior Mining Company on April 29th during this trial?

A. I was.

Q. 36. What in particular were your duties at that inspection?

A. My duties on that day were to receive from the representatives of the Minerals Separation who took samples the samples as they were prepared and to

seal them and to make a record of them and to see that they were brought to my laboratory safely.

Q. 37. Did you make determinations from the specimens that were thus obtained?

A. I did.

Q. 38. I now show you plaintiff's exhibit 252, and ask you first whether or not you made a determination of the percentage of sharps and slimes in the concentrates and tailings which were of these specimens?

A. I did.

Q. 39. In what manner did you determine what were sharps and what were slimes?

A. By taking the whole sample as received, being suspended in water and stirring it up so that it was uniform and allowing it to settle for one minute and then drawing off the slime, leaving behind the sharps which had settled.

Q. 40. And the percentages stated in this table are those that you arrived at by that method of determination?

A. Yes, the figures given for the weight of concentrate slimes and concentrate sharps are related to each other in exactly the way in which I found them to be.

Q. 41. Have you separated the sharps and slimes? Did you separately assay those different products.

A. I did.

Q. 42. And are the facts given in this table those that you determined?

A. Yes, they are.

Parker C. McIlhiney.

Q. 43. And did you make any determination of separated products?

A. Yes, I did.

Q. 44. And are those the figures of this table?

A. Yes, they are.

Q. 45. The separation into volatile oils recovered and non-volatile oils recovered was or was not that made in the same manner as in regard to the Utah specimens?

A. It was with regard to several of the Utah specimens, but I did not separate the volatile from the non-volatile in all of the Utah specimens. In other respects they were the same method of examination.

Q. 46. In so far as these appear on this table and in the Utah table, the method is the same, is it not.

A. Yes.

Whereupon an adjournment was taken until 10:00 A. M., Monday, May 14th, 1917.

Monday, May 14th, 1917, 10 a. m.

MR. WILLIAMS: If your honor please, in this suit, as we started with the original pleadings four weeks ago today, I said to your honor that the issues as presented were validity and infringement by the defendant at or before the filing of the bill of complaint in October, 1913. We presented a very short opening case, establishing those facts from the view-point of the plaintiff, and the trial proceeded. The defendant proved that, since the first of January, 1917,

and since the decision of the Supreme Court of the United States in the Hyde case, it had continued its operations with the sole variation of the addition of considerable quantities of oil, and the very definite use of soluble frothing agents. The facts relative to those proceedings of the defendant have very fully appeared. In the course of the trial we filed a supplemental bill, and in that supplemental bill we brought in certain new parties, and I may say that under that supplemental bill all the facts as to title have been practically stipulated, insofar as they were not previously stipulated. In that supplemental bill we allege that the acts of the defendant which were instigated by the defendant Hyde or started by the defendant Hyde, have continued, and of course the meaning of that is that they continued up to the time of the filing of that supplemental bill of complaint.

Then in connection with the matter of the disclaimer, we made, in the supplemental bill a charge of infringement, and that was a general charge of the continuance of the infringement up to the time of the filing of the supplemental bill of complaint. Upon careful scrutiny of that supplemental bill it seems to us that the definite charge of infringement of the other claims, which were charged to be infringe~~ment~~d in the original bill, claims 1, 2, 3, 5, 6, 7 and 12, they should be incorporated in the supplemental bill, to squarely present the issues that have been in fact raised by the evidence in this trial—therefore we ask leave of court to amend the supplemental bill of complaint which I now hand your honor, by inserting in clause 7 thereof, line

3 from the bottom, after the word "disclaimer," the following: "As well as claims 1, 2, 3, 5, 6, 7 and 12 of said letters patent", so that the clause reads: "That the processes recited in claims 9, 10 and 11 in said letters patent 835120, as limited by said disclaimer, are new and original inventions of the patentees thereof; and said claims 9, 10 and 11 of said letters patent 835120 as limited by said disclaimer are good and valid and that the Butte & Superior Mining Company had, subsequent to the issue of said letters patent No. 835120, and prior to the filing of the bill of complaint herein, and without the license or allowance of the plaintiffs or either of them, employed processes of concentrating powdered ores covering and containing said invention and inventions, in infringement of claims 9, 10 and 11 of said letters patent 835120, as well as claims 1, 2, 3, ~~4~~ 5 6, 7 and 12 of said letters patent, and continues so to do, and has encouraged and induced others so to infringe." I would change that word "continue" to "continues". I informed the defendant this morning of our intention, so as not to make it a matter of surprise.

MR. KREMER: We desire to object to the amendment at this time as untimely. It certainly comes at a very late hour, and we object to it particularly for the reason that it entirely changes the cause of action attempted to be set forth in the supplemental bill of complaint. Reducing it to simple language, we find that in the supplemental bill which was filed over objection, as your honor will recall, there was an allegation of continuing alleged infringement of claims 9,

10, and 11, those claims of the patent which had to do with the use of more than one per cent of oil. The purpose was, as set forth in the supplemental bill, to confine it to those particular claims in order that they might raise an issue upon those claims which they omitted to disclaim. Now, after having so framed their pleading, they desire to amend them so as to extend it to all those claims of the patent which are entirely without the purview of claims 9, 10, and 11, the claims with reference to which the pleading was originally drawn and intended to be drawn. I believe that I can make the statement quite that strong, "intended to be drawn," because of the fact that the allegations immediately preceding are the allegations having to do with the disclaimer of this particular claim, and all of the disclaimer is set forth there by way of inducement to the particular part of infringement of 9, 10 and 11. So it seems to me, that if we are to construe the paper as it is drawn, that we can reach no other conclusion than that the cause of action attempted there to be set forth is a cause of action for the infringement of these particular claims which they allege that they disclaim. So, we object to it for that reason; and in addition to that we would interpose the same objection that we interposed to the filing of the supplemental bill.

MR. WILLIAMS: May I read to your honor the other clause of the supplemental bill which brings in these continuing acts, although not quite as definitely as we want them. That is on page 8 of the supplemental bill commencing with line four.

MR. KREMER: That is a part of your amended

bill, isn't it? That is your amended bill of complaint, not your supplemental bill, and is so embodied in your amended bill under a notice that you served that it would be inserted in your amended bill of complaint upon a certain page and at a certain line. Page 8 is not a part of your supplemental bill. It is a part of your amended bill of complaint.

MR. WILLIAMS: The claim is that the process introduced by the said Hyde into the Butte & Superior Mining Company's plant was continued in use by the said company, the defendant here, by and through other employes and under other superintendence, and in other plants. That is the allegation. Now, that is all the more reason for not segregating, after such a trial as we have had and after the introduction of such evidence as we have had, for not segregating the cause of the continuance of infringed claims 9, 10 and 11 from the other claims which were originally charged to be infringed. The pleading as it stands, without this amendment, would seem to support that special issue, and it is deemed advisable by all means that the pleading should set forth the issues which the trial of this case has practically brought forward by proof of the facts brought forward by the defendant. Mr. Kenyon wants to say a word.

MR. KENYON: The original bill of complaint brought by the Minerals Separation, Limited, alleged infringement of all of the claims, 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12. When the other two defendants were joined by this supplemental bill they thereby joined

in this alleged charge of infringement of all the claims. They became a party to them without themselves specifically repeating the charge of infringement that the owner of the legal title, acting for itself and for them had made. Now, the disclaimer coming along did not have to be pleaded by supplemental bill at all. The authorities so hold. It may be pleaded and it may not be pleaded. It need not be pleaded. Had it not been pleaded, it would by operation of law nevertheless relate back to the original pleading of infringement of claims 9, 10 and 11. And that original pleading made three or four years ago, would, by operation of law, and by effect of the disclaimer, become a pleading that claims 9, 10 and 11, so subsequently limited by disclaimer, had been infringed prior to the filing of the bill. That is the legal effect of a disclaimer under the authorities, that it relates back to the time of issue of the patent, takes effect from the time of issue of the patent, and the claims affected by the disclaimer are in contemplation of law as if they had been disclaimed from the day the patent issued; and all cases of infringement are to be determined on that theory. So we need not at all have pleaded this disclaimer nor need we have in the name of the two new parties alleged anew an infringement that had been comprehensively alleged in the original bill. And that clause 7 therefore, in contemplation of law, adds nothing to the allegations of infringement of the original bill, excepting only the one item, the words "and continues so to do." That is to say, it adds to the allegation of the original bill that the act of infringement was con-

tinuing at the date of the filing of the supplemental bill. The allegation was that the act of infringement of these three claims as limited by the disclaimer was continuing. Now, the relation of these three claims as limited by disclaimer to the other claims is, as your honor has certainly held in dealing with this matter of disclaimer, that these three claims certainly cover and included in their original form what the other claims covered and included. They cover and include all of them.

And if they differ from these other claims, they differ only in covering more. Now, by disclaimer we have cut down that "more" to something less than it was originally, but still not to something less than these other claims. It still remains that these claims 9, 10, and 11 as limited by disclaimer are, if they differ at all from the other claims, broader than the other claims. Therefore, the allegation of infringement of these broader claims includes the allegation of infringement of the narrower ones, necessarily, in the nature of the case. And our motion merely is that that allegation of infringement there, the only now feature of which is the continuing of the infringement up to the date of the filing of the supplemental bill, shall be the comprehensive including, not only claims 9, 10 and 11 as limited by disclaimer, which are the broadest claims in the complaint, but also claims 1, 2, 3, 5, 6, 7 and 12, the narrower ones, if there be any difference. So that nothing new is introduced, nothing new of substance is introduced by the amendment we ask to be

permitted to make; and this merely brings the pleading to conform exactly to the proof.

MR. KRAMER: If your honor pleases, it seems to me that if the statement of counsel is to be taken as given, that that confesses that this application is an entirely useless application. That in itself would be a sufficient ground of objection. But the situation is this, briefly: I do not know whether your honor has examined these pleadings since we have amended them, and supplemental pleadings have been filed; if not, I can briefly state it this way: To the original complaint as filed, an application was made to file an amended and supplemental bill. The application was a joint application insofar as the amendment and the supplemental pleadings are concerned. Well, under the rule of practice, the amendment would have to be made to the original complaint. The supplemental complaint is, of course, as its name implies, something that follows afterwards; therefore, paragraph 8, to which Mr. Williams referred, being an amendment to the original complaint, was embodied in the original complaint under the rule of practice by notice that that should become a part of the original complaint at a certain point and place. And that was done. Therefore parapragh 8 of their application, the paragraph to which Mr. Williams refers, was made a part and was an amendment to the original complaint. Now that left the supplemental complaint a separate and distinct pleading. Now, in that supplemental complaint, the supplemental complaint having to do only with those

things which had transpired since the filing of the original complaint and applying the rule that Mr. Kenyon has set forth that the disclaimer relates back to the time of the issuance of the patent, and of course that would be at a time preceding the filing of the original complaint—therefore we find that in the supplemental complaint as filed, a separate and distinct ground of recovery was set up. We argued that at the time, and that was filed.

Now, in that supplemental bill of complaint they specifically confine themselves to the use by the defendant of claims 9, 10 and 11. It is all very well for these gentlemen to say that of course the original complaint covers it all. If it covers it all, then they should be satisfied. But the difficulty is this, and we might as well meet the crux of the situation—that perhaps they have some fear of the application of the rule of "Expressio unis, ulterior exclusio est." I think that is the correct quotation.

MR. WILLIAMS: Very fine; very fine.

MR. KREMER: The expression in that supplemental bill of one particular act is to the exclusion of every other act, and now that is the situation that is presented to your honor, and I believe that that is the legal effect of it. Now, the question is, can they change their supplemental bill so as to show or to change their cuase of action to cover that which they had no intention of covering, if we are to judge from their pleadings, at the time that their application was made to file that supplemental bill. Now, I think that

is the situation. I do not know that I can add anything further to the statement than that it is a mere simple statement of law and fact.

THE COURT: Let us see where we are at. If we have been sitting here four weeks trying claims 9, 10 and 11, instead of the whole patent, it is time the court understood the fact. It has been understood that we were trying the whole patent except Nos. 4 and 8, I think it is. Your purpose is to incorporate in paragraph 7, claims 1, 2, 3, 5, 6, 7 and 12, which your fears incline you to believe may not be there?

MR. WILLIAMS: Yes, your honor.

THE COURT: And your understanding is that we have been trying those?

MR. WILLIAMS: Yes, your honor.

THE COURT: And you think you have been trying only 9, 10 and 11?

MR. KREMER: No, your honor, I can not say that; I would not make that statement. I say that on these pleadings we have been trying all the claims of this patent except insofar as the allegations of that supplemental bill limit ~~to~~ them to the right to try them. In other words, since the disclaimer was filed and since the decision, we know that the Supreme Court of the United States declared them invalid; therefore I think that under these pleadings we have a right to assume that in the continued user of that process under the pleadings should be limited to 9, 10 and 11; they allege that we have continued to use it at all times.

THE COURT: Yes, I see. Your contention is that we have been trying it as far as the user is concerned, under claims 9, 10 and 11.

MR. KREMER: Your honor understands that under these pleadings—confining it to the pleadings, for I do not want to make a general statement——

THE COURT: Well, you think they are fearful, and perhaps they are. Well, it might be useless, but it is an ancient and unalienable right to cast out anchors to windward, for counsel to take precautions and to multiply pleadings and words for fear there might be some loophole through which the opposite party might escape and the pleader be hurt. It is in line, of course, with the safety-first theory, to make sure; and so, it is for the benefit of the court as well, so that the court will not be compelled to try this case over again. I certainly do not want to try this case again.

Everything has proceeded very harmoniously, counsel have made less difficulties than we have often seen in this court, and perhaps the court has made less trouble; but I do not want to go over this ground again; I want it all tried here and now. It can not be any element of surprise. I think we all understood that these claims, 1, 2, 3, 5, 6, 7, and 12, were being tried. I realize now for the first time that 9, 10 and 11 are being tried; I thought 9, 10 and 11 were excluded. I must have misunderstood the language of counsel, for I certainly understood that 9, 10 and 11 were excluded from consideration, and I certainly

understood that 1, 2, 3, 5, 6, 7, and 12 were being tried. So this amendment is in line with making it clear and explicit now, so we will not have to try it again, therefore the amendment will be allowed and an exception may be noted.

(Defendant excepted.)

MR. KREMER: At this time, without redrafting the pleadings, I will ask if we may insert in the original a line which is in accordance with the pleading. I do not want to say "denial," because I don't know just what it will be, but I want to interline the amendment to keep from redrafting the whole pleadings, which are voluminous.

THE COURT: Very well; if you make an amendment by interlineation, you can do that, but before you do it you had better call it to the attention of the other side and submit it to the court so that it will be understood.

MR. KREMER: Yes, your honor, we will submit it. We will present it to the clerk and have him initial it.

THE COURT: Very well.

DR. McILHINEY, recalled for further

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 49. Dr. McIlhiney, additionally to the determinations made by you of specimens of the—from the Butte & Superior mill that are set forth in plaintiff's

Parker C. McIlhiney.

exhibit 252, have you made a determination of the zinc and oil contained on the tailings from cleaner No. 2?

A. I have.

Q. 50. What was your determination?

A. I found in those tailings 8.60% of zinc and 2.02% of oil.

Q. 51. You may state what the corresponding determination by the Butte & Superior Mining Company are as they are stated in Exhibit 227.

A. Where I found 8.60% of zinc, they report 8.65%; where I report 2.02% of oil they have 2.24%.

Q. 52. BY THE COURT: More than yours?

A. Yes, sir.

Q. 53. MR. WILLIAMS: Have you found any general relation of their oil determinations to your oil determinations?

A. I have not. Sometimes, as I recall them, they are higher and sometimes they are lower, though the totals agree fairly.

Q. 54. BY THE COURT: Let the court be clear on this. Is this the tailings from cleaner No. 2?

MR. WILLIAMS: Tailings from cleaner No. 2 which was sent to waste; 8.60% of zinc.

THE COURT: Proceed.

Q. 5~~4~~5. MR. WILLIAMS: Did you make any examination of the pulp obtained from defendant's mill, for the purpose of determining whether or not there was pine oil in the pulp?

A. I did.

Q. 56. And what did you find?

A. I found that there was pine oil.

Q. 57. Have you made examination of the pine oils supplied by the defendant to determine whether or not they contain a soluble frothing agent?

A. I have made such determinations.

Q. 58. And do you find that the pine oil, besides containing a soluble frothing agent, contains insoluble material?

A. Yes; the pine oil contains both soluble and insoluble portions.

Q. 59. Did you examine specimens obtained from the defendant of an operation performed in court by Dr. Sadtler in a gabbett, said to represent the disclosure of the California Journal of Technology?

A. I did examine such a specimen.

Q. 60. What did you find as to the copper content—it having been stated that the ore was a copper ore?

A. I found that the ore itself contained .85% of copper; that the concentrate contained 2.33%, and that the tailings contained .59%.

Q. 61. And what was the recovery, on those figures?

A. That would indicate a recovery of 40.96%.

Q. 62. Did you examine the specimen of kerosene oil supplied by the defendant as corresponding to that used by Mr. Phillips in his 25% kerosene oil experiment made in court?

Parker C. McIlhiney.

A. I did.

Q. 63. What was your examination and what did you find?

A. I found that it contained a soluble frothing agent, and I separated that frothing agent from the main body of the oil by dissolving it in water, and examined the water separately, and found that it gave every evidence of containing a soluble frothing agent.

Q. 64. Did you make any concentration?

A. Yes; I not only examined the water solution itself, but I concentrated the ingredients into a smaller volume by distillation or by rectification, and found that the liquid when concentrated gave more marked indications than the original water solution from which that rectified material was obtained.

Q. 65. Was there any odor about it?

A. Yes, there was. The water, after having been separated from the kerosene, carefully, had an odor which was entirely different from that of kerosene, which was rather indeterminate in character, but I should be most inclined to refer it to some kind of pine oil or some trace of wood product.

Q. 66. Did you examine the specimen of kerosene or petroleum distillate supplied by the defendant as corresponding to that used by Mr. Dosenbach in his experiment with 25% of kerosene, said to represent the Kirby patent?

A. I did, and I found the material to show qualita-

Parker C. McIlhiney.

tively the same character as the kerosene sample that I have just described.

Q. 67. That is to say, what did it contain?

A. A soluble frothing agent.

Q. 68. Did you make any tests of the Butte & Superior oils for the purpose of determining the presence or absence of grease?

A. I did; I examined the oils which I had extracted from the various products, and I found that they all contained a large proportion—say from between one-half to two-thirds of a solid grease. I examined this solid grease particularly in the case of that obtained from the slimes of concentrates, and I found that it had a melting point of approximately 36° C., and that in that case it constituted 47.6% of the whole of the oil which had been extracted from those concentrate slimes.

Q. 69. I have computed as 97° F. about; will you accept that computation?

A. I will not dispute that computation.

Q. 70. Did you separate this solid material?

A. I separated it in the course of the analysis that I made of all these Butte & Superior materials.

Q. 71. Have you a specimen with you?

A. I have. (Producing small bottle.)

Q. 72. I note that you have marked upon the bottle containing this specimen "non-volatile oil recovered from slimes concentrates, defendant's plant, April 29th, 1917." Is that a proper description of this specimen that you have produced?

Parker C. McIlhiney.

A. It is.

MR. WILLIAMS: I offer the specimen in evidence.

Specimen admitted without objection marked PLAINTIFF'S EXHIBIT No. 276.

CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 73. Could you say, or do you know that the solid grease you say you got from the concentrate slimes was not adsorbed at the surface of the bubbles and therefore not active in the flotation operation?

MR. WILLIAMS: It rather seems to me that the question covers a scientific theory of the operation as carried on, and the witness has come here and told us of the results of the examination of the products only. It seems to me the scope of the question is beyond that of the direct examination, and that it is inadmissible.

MR. SCOTT: I think I will accept your honor's ruling without argument.

THE COURT: It seems to me that that is so; anything within the range of the direct examination, of course, is proper, or anything within the range of the science disclosed in this examination. It seems to me now that you are going into the practice and theory of flotation, while this gentleman testified only

as to the results of certain assays. The objection will be sustained.

Defendant excepted.

MR. SCOTT: No further cross examination.

DR. WILLIAM MASON GROSVENOR, Recalled, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Dr. Grosvenor you exhibited to the court certain moving pictures. Please state whether or not these pictures were prepared under your direction and supervision and in your presence; and in general whether you took precautions to see that the experiments of a reliable character and that they were accurately portrayed in the pictures?

A. Every such precaution was taken. No one of the pictures was taken out of my presence, and in nearly every case I participated in the actual operation, either manipulating the experiment or operating the camera. In some cases the work was of such a character that I preferred to have someone else do both of these things in order that I might watch with greater care exactly what was going on and be able to identify the accuracy of the picture presentation of it. There is no one of these pictures that does not correspond exactly with what I saw, so far as the quickness of the eye would permit it to be seen, and

P. 4706, L. 15, insert " portrayed by these moving pictures were experiments " after " ments "

William Mason Grosvenor.

not once but many times, because these experiments were all repeated in various forms in order to ascertain the methods which would most clearly photograph the thing we had learned to know occurred. When taken, the negatives were in every case marked for identification and in almost every case were developed in my presence. Having identified negatives it is always possible to identify with certainty the correctness of the positives prepared from those negatives.

Q. 2. And have you done so with these pictures?

A. That has been done; and, beyond that, the facts which the positives represent I know to have been the thing which occurred.

MR. WILLIAMS: I offer in evidence the moving picture films.

Picture films admitted in evidence and marked PLAINTIFF'S EXHIBIT 277.

MR. WILLIAMS: There is a stipulation which we made when the defendant showed magic lantern slides, that the film should remain in the custody of counsel, but we propose to leave these films with your honor during the time that the case is under consideration, because they may be separately examined with a magnifying glass for the purpose of determining any question.

Q. 3. Now, Dr. Grosvenor, did you attend the magic lantern exhibition of Prof. Phillips, and have you examined the photographs that were offered in evidence during his testimony?

William Mason Grosvenor.

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Q. 3. Now, Dr. Grosvenor, did you attend the magic lantern exhibition of Prof. Phillips, and have you examined the photographs that were offered in evidence during his testimony?

A. I did both.

Q. 4. What have you to say generally as to those photographs?

A. That the photographic work was excellent and accurately portrayed what was seen under the conditions present; but that the conditions chosen for photographing were of a character that did not at all disclose the critical or important points with regard to the character or composition or the construction of the froth. That instead of representing a froth in layers of such thickness and so illuminated that it would be possible to judge anything about the construction of the froth, the conditions chosen for the photographs were those which would represent the surface similarity of the froth and give us no information as to their make-up. I would, therefore, regard them as having no technical value in deciding what the character of the froth was and certainly no value in deciding as to its recovery or composition.

Q. 5. There was a phenomenon to which attention was called when these photographs were exhibited, what I might call the "two spot" phenomenon? What have you to say in regard to that?

A. That I cannot attach any such importance to that as was indicated by Prof. Taggart's testimony because while the dual spot may possibly have been due to the reflect~~ion~~ed layer of oil on the inside of the bubble between the air and the metallic particle, I have made hundreds if not thousands of photo-

William Mason Grosvenor.

graphs of the actual interiors of the bubbles themselves, taken with the sectional bubble holder that was spoken of the other day, close up against the side of a cell so that I was able to photograph directly what was going on within the bubble, and it has been proven very clearly that just such reflections may be obtained from layers of particles where they can be seen quite clearly exposed to the air on the inside of the bubble with no modifying agent of any kind present in the mixture. In fact, one of the chief difficulties that I have so far been unable wholly to overcome, so as to secure satisfactory pictures for projection of just what is going on inside the bubbles, has been that there have been so many reflections, there have been so many difficulties in securing the absence of reflections from the film itself, what we call hallation effect, the brilliant glarey spots in pictures due to excessive light diffused from a point, I have been unable to eliminate. That I think is supported by each of the pictures themselves because they by no means exhibit a universality of two spots. In many cases there are more than two, and in some cases there do not seem to be any. The reflections from the interiors of such bubbles are extremely complicated, and as I say I have found it almost impossible to get simply illuminating effects.

Q. 6. Now, have you any photographs taken from parts of the films that you would like to put in evidence.

A. In connection with the question of oil and air

froths and particularly the photographic presentation of the froths that are shown as microscopic slides, I have selected a few of the pictures from the films for reproduction and enlargement in order to show that, properly taken, it is easy to see when illuminated from the rear a great deal of the actual structure of the froths themselves. That is not only clearly indicated by the projection on the screen, but is indicated where it can be more easily examined in these enlargements. In the air froth of which these five constitute the series, it is possible to see, when properly illuminated, not merely the face of the bubble but see through the bubble and judge to a great extent the location and character of attachment of the mineral particle when the froth was manipulated, as this froth was during the taking of the moving pictures, between glass frames, through the rear one of which the illumination was past and through the front one of which the picture was taken.

The numbers on the back of these photographs are rather algebraic, but A-1, A2, A3, A4 and A5 are the air froths. The numbers 1, 2, 3, 4 and 5, indicate the order in which they were selected as the froth was more and more manipulated. In a similar manner 01, 2, 3, 4 indicate the order of the pictures taken of the oil froths, the characteristic difference being that the oil froth does not show either the transparency between the granules of mineral on the bubbles or the attachment of the particles of mineral

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to the edges of the bubbles during manipulation, as the air moved in and out of the froth.

Q. 7. Now, what does the photograph marked 04 show?

A. It shows the residue of oil entrapp~~ed~~ing mineral from which manipulation has enabled or caused sufficient of the air to slip away so that the buoyancy of the froth as a whole was not sufficient to support its load of mineral, and it corresponds roughly to the sinking portion of the Elmore float indicated in one of the pictures where the oil became overloaded by too much of mineral and dropped to the bottom. That is a photograph of this oil froth after the escape of a portion of the air dropping to the bottom and passing out of the frame work of the picture, beyond the reach of the lens.

MR. WILLIAMS: The photographs produced by the witness are offered in evidence.

Photograph O-1 admitted in evidence and marked PLAINTIFF'S EXHIBIT 278.

Photograph O-2 admitted in evidence and marked PLAINTIFF'S EXHIBIT 279.

Photograph O-3 admitted in evidence and marked PLAINTIFF'S EXHIBIT 280.

Photograph O-4 admitted in evidence and marked PLAINTIFF'S EXHIBIT 281.

Photograph A-1 admitted in evidence and marked PLAINTIFF'S EXHIBIT 282.

Photograph A-2 admitted in evidence and marked PLAINTIFF'S EXHIBIT 283.

Photograph A-3 admitted in evidence and marked PLAINTIFF'S EXHIBIT 284.

Photograph A-4 admitted in evidence and marked PLAINTIFF'S EXHIBIT 285.

Photograph A-5 admitted in evidence and marked PLAINTIFF'S EXHIBIT 286.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 8. Do I understand you, doctor, to say that these are reproductions from the moving picture films?

A. They are.

X-Q. 9. From the ones that were exhibited?

A. Yes, enlargements of certain individual pictures along the line and the numbers indicate—although not in equal division—they indicate the order in which these pictures succeeded each other somewhere in the line.

X-Q. 10. Then the set that you have marked with the letter "A," A-1 to A-5, they represent the same froth?

A. Air froth, yes.

X-Q. 11. And the same one?

A. The same one that is shown in the moving pictures.

X-Q. 12. And I have forgotten the amount of

William Mason Grosvenor.

oil that was used in making this air froth?

A. Do you want it accurately or approximately?

X-Q. 13. Oh, approximately.

A. About two-tenths of a per cent; merely a small amount.

X-Q. 14. And this other one as I remember was about 16 or 17 per cent?

A. Approximately that.

X-Q. 15. Do the moving pictures show any contrast between froths where the quantity of oil does not differ so much as in the case of these two sets that have just been introduced?

A. They do. I don't suppose you mean these particular ones because these particular ones were just of particular froths. But the same thing is shown in other pictures, the same difference, not in degree, not in the same way exactly, but the difference is photographed.

X-Q. 16. Now, in commenting on Mr. Phillips' pictures you stated that they were not taken in such a way as to exhibit the important characteristics of the froth. Now, I wish you would state what these important characteristics are?

A. From the indications in my experimental work it is quite important to know with regard to the froth whether there is a considerable excess of oil immediately associated in contact with the air and the mineral coming between the two. That could not, so far as I can see, be judged from these photographs.

William Mason Grosvenor.

X-Q. 16A. And that is the thing which I take it you regard as constituting the distinction between what you term an air froth and what you term an oil froth, namely, the amount of oil separating the mineral from the air contained in the bubbles?

A. In a sense, yes. In a mineral froth it is possible to judge whether the mineral is attached to the air bubble by such examination, and I think that attachment is the vital thing.

X-Q. 17. And in its final analysis this question of distinction in the mode of attachment resolves itself merely into what you referred to before, doesn't it, namely the thickness of the oil layer or the thickness of the oil intervening between the mineral particle and the interior of the bubble?

A. No, that does not by any means.

X-Q. 18. That is what I was trying to get at.

A. I think my testimony has made it quite clear that whether things do attach or do not attach is dependent upon the strain to which they are subject, the character of the materials between them, and in this specific instance the size of the particle. There are many of those conditions. But what I meant to bring out was that with the froth ~~the oil~~ under consideration, the reason for taking such photograph is that it shows the presence or absence of the oil, which is vital. That is, not merely the amount of oil which is poured into the system, but the amount of oil which is actually engaged in co-operative action between the bubble and the mineral. An immense amount of excess oil,

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either useless or harmful may be put in. But by examination of the froth it is possible in my opinion to determine whether the effects of that oil has been injurious, provided the pictures are taken in the proper way.

X-Q. 19. Well, now, knowing that you do not profess to be conversant with metallurgical practices, allowing for that fact, but just as a matter of ordinary common sense wouldn't you think that the real test of whether the excess of oil was injurious and was interfering with the process would be the practical results obtained, namely the efficient recovery of a desired mineral.

A. If I were satisfied, as I am not by any means, I have testified to the contrary, that such oil as was put in might and must of necessity take part in the actual operation of flotation, I would be. But if you simply tell me that so many pounds of oil have been put into the system, and that you have made such a recovery, admitting that the recovery may be excellent, it does not follow that these oils were not capable of being injurious, if they had been left in a position to exercise their injurious function.

X-Q. 20. Well, the fact that we have assumed that the recovery is satisfactory would in itself be evidence, would it not, that the oil had been present in such a way as not to function injuriously?

A. If the recovery were satisfactory it would indicate to my mind that something had been done to prevent that oil from doing harm.

X-Q. 21. And, for instance, what might some of those things be that could be done to prevent the oil from doing harm?

A. Over aeration, and carrying it away in the bubbles, over agitation or emulsification or a number of things may cause it.

X-Q. 22. By "over aeration" I take it that you mean agitation sufficient to create enough bubbles to adsorb the oil?

A. That would be one way of putting it. Another way would be agitating it so as to offset the possible injurious effects of the excess oil.

X-Q. 23. Now, doctor, will you explain the mechanism that you used in getting the magnified bubble pictures which you exhibited in the motion pictures?

A. To simplify that explanation I took the liberty of making a sketch, which is very rough, but will illustrate the type of apparatus used and is something like—somewhat near about half size. The upper portion of the apparatus marked "A" is merely a chamber or box for receiving the liquid and providing a sort of reservoir for any excess or variation in the column that there might be with the entrainment of air. That in the particular apparatus used was made of wood painted on the inside with, as I recall it, an asphalt paint. I satisfied myself that it had no modifying action on the liquid by testing it. The part marked "B" consists of a flat rectangular column of optical plate glass of approximately the section shown through which the current of liquid

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passed downward, and at the bottom of which there was the so-called bubble tube, or an alundum bubbling tube, which, consisted of a brass tube in the upper edge of which is a tube of alundum through which the air can be forced.

X-Q. 24. by Mr Williams What kind of material is alundum?

A. Alundum is a product of the Northern Abrasive Company, I think the name is, of Niagara Falls, and it is a fused oxide of aluminum. It was selected because of its great porosity and extreme fineness of its pores so that we could introduce air in very minute streams and ascertain the tendency to aggregate and coalesce, or on the other hand the action of the frothing agent in preventing ~~each~~ such coalescence. The choice of this particularly finely grained material was dictated by the fact that it is non-metallic in character and therefore the bubbles do not tend to gather and aggregate on its surface and produce what might be called false or premature coalescence. Well, returning to the diagram. Air pressure applied to the cell of the alundum tube marked "C" would cause the air to bubble up through the falling volume of liquid in the observing chamber "B"; and if nothing were done to prevent the rise of liquid in that column the air bubbles would tend to make that liquid rise. To overcome that tendency a continuous circuit was secured through the lower block of the apparatus "D," and a return pipe "E" of glass which served to carry the liquid back into the reservoir. The action of the pipe "E" gives rise for

the name attached to the cell, "the air lift cell" because by injecting air at the bottom—

X-Q. 25. MR. WILLIAMS: Mark the pipe through which air is injected.

A. By injecting air into the bottom of the column "E" through the pipe "F," it is possible to cause a continuous and even rise of the liquid in the column "E" and maintain an active circulation in the apparatus; and likewise possible to control the rate of that circulation so that the rising of the bubbles here in the column "B" could be retarded to a sufficient extent to permit us to get a series of photographs that would make the progressive approach and coalescence clearly visible in the moving picture. Unless we have about nine pictures of anything which is passing across the field of view, the pictures become jumpy and it is difficult, if not impossible, to follow the smooth progressive movement. That is the reason for selecting this method of observation, because it is tantamount to moving our camera upward with the bubble or moving the vessel of liquid downward against it.

MR. WILLIAMS: I offer the diagram prepared by Dr. Grosvenor in evidence.

Diagram admitted in evidence and marked

PLAINTIFF'S EXHIBIT 287.

MR. KENYON: To complete the matter of title, plaintiff's counsel offers in evidence the agreement

William Mason Grosvenor.

of July 8th, 1913, between Minerals Separation, Limited, and Minerals Separation American Syndicate, 1913, Limited, being Exhibit A attached to the supplemental Bill of Complaint, and the same is marked plaintiff's exhibit No. 288.

Document admitted in evidence as PLAINTIFF'S EXHIBIT 288.

MR. KENYON: Also a copy of the bill of sale from Minerals Separation American Syndicate, 1913, Limited, to Minerals Separation, North American Corporation, being exhibit B attached to the supplemental, bill of complaint and the same is marked Plaintiff's exhibit No. 289.

Bill of Sale admitted in evidence marked PLAINTIFF'S EXHIBIT No. 289.

MR. KENYON: It is stipulated that exhibits 288 and 289 may be received in evidence with the full force and effect that the originals themselves would have had?

MR. KREMER: Yes; you state that they are copies of the original?

MR. KENYON: Yes, they are copies of the exhibits attached to the complaint.

MR. KREMER: It is covered by the general stipulation, I believe.

JAMES WILDING, recalled for further

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. MR. KENYON: Mr. Wilding desires to make a few corrections.

THE WITNESS: If your honor please, I would like to make an explanation in regard to the tables submitted on Saturday afternoon, and also to make two corrections in my answers to questions of counsel for the defendant.

Explanation of the tables. My four tables contain columns which were not used at all in arriving at the ultimate answer of results. They are the columns of Ratio of Concentration, the tons of tailings, and the assays of tailings. They are of interest as showing the degree of accuracy with which the operations leading to the figures on defendants Exhibit's had been carried out; but had they been omitted, the result would be the same.

The corrections I would like to make are in answer to Mr. Scott's questions Nos. 278 and 279, page 2653 of the transcript. In the first question, No. 278 was, "taken by reliable sampling means," and 279, "and assayed presumably by reliable assayers?" My answers to these questions was yes. I did not mean to express any opinion as to the reliability of the methods of sampling and assaying at the Chino

James Wilding.

mill. I don't know what those methods are. In a previous answer I had given an opinion that the work on which Mr. Wicks' figures were based must have been inaccurate, as they are not reasonably consistent with each other, and I could not say at what stage the work was inaccurate. My own work on these figures was pure arithmetic, as I explained, and is accurate.

In answer to Mr. Scott's question 288, I said "I can not express an opinion of the accuracy of the work." I was speaking of Mr. Wicks' figures, and not of my own, and meant that I could not express an opinion as to the accuracy of any particular portion of that work over that of any other. I had already stated that some portion or other of the work must be inaccurate.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 2. Referring to exhibit 255, Mr. Wicks' report, now for illustration, and to follow your method definitely, I wish you would take the entry for October, 1916, and simply show us your calculation for arriving at the horizontal line of entry opposite October, 1916. If you can do it upon a piece of paper or upon the blackboard there it will probably be better.

A. October, 1916; that is exhibit 29. Tons of flotation headings—

X-Q. 3. If not inconvenient I think it would help us if you would make the calculation on the board.

A. All right, sir. I will do that. We have here from exhibit 29, 9794 tons of heading. The copper assay is given as 7.77%. Multiplying 9794 by .0777, you get the number of tons of copper in that heading. Multiplying that number of tons of copper by 2000 you get the number of pounds of copper in that heading. The number of pounds of copper in the heading, 1,521,988, that is multiplied by 2000, as 2000 pounds are contained in a ton. Tons of flotation concentrate given in exhibit 29 is 2884. The assay given is 26.03. Multiplying by .2603 and again by 2000 and we have the pounds of copper contained in the concentrate, which is 1,501,410. The relation between these two figures expressed in per cent gives us the calculated recovery figure; that is to say; this figure divided by that will give 98.65%. Is that satisfactory?

X-Q. 4. That is very clear, yes.

A. We have then the column of tons of tailings, which is simply by difference; 9794 minus 2884 equals 6910. Pounds of copper contained in tailings by difference again, 20,578.

X-Q. 5. BY MR. KENYON: You had better set above that last figure what it is.

A. Pounds of copper in tailings. Next, assay of copper calculated, which is obtained by dividing the pounds of copper by the tons of tailings, in which case we get the pounds of copper in each ton of tail-

James Wilding.

ings. I haven't the intermediate figure here, but of course to express it by per cent, you divide it by twenty. The result is .149% of copper in the tailings. The pounds of copper lost per ton of heading will be then 20,578 divided by 9794, which is 2.10. The value of that 2.10 pounds of copper at 20 cents—

X-Q. 6. Now, Mr. Wilding, unless the others desire to have it, you have gone far enough to illustrate what I wanted.

X-Q. 7. MR. KENYON: Write here what this is, pounds of copper in what, and also this.

A. Pounds of copper in heading and pounds of copper in tailing per ton of heading.

X-Q. 8. MR. SCOTT: Now, Mr. Wilding, just so that we may come to an understanding, the basis of your calculations when you started to make them was that these concentrates were actually weighed —wasn't it?

A. That was my idea, over any period of three months, for instance. On Saturday you referred to the third quarter—over any period of three months one does expect reports of the actual weights.

X-Q. 9. But there was a misunderstanding in that respect?

A. Yes.

X-Q. 10. And inasmuch as these concentrate weights do not represent actual weighing operations, you would not expect to be able to correct the tailing assays by this system of computation which you have used, would you?

James Wilding.

A. I would put it another way, Mr. Scott, if I may be allowed. By calculation from these assays of heads, concentrates and tailings, then we arrive at certain recovery figures; and then by using that recovery figure we arrive at a certain weight of concentrates produced. If that weight be wrong, then it is a necessary conclusion that the work on which the figures are founded is wrong at some one stage or portion of the total operations.

X-Q. 11. I understand.

A. Let us suppose that the computations are accurate. Now, one never does expect checks, that is, accurate—that is, absolute checks; that, of course, can not be. One does expect reasonable checks in calculating back. For instance, I will give you a case right here, which also is in evidence. Here we have a given assay for the first quarter of 1917 on exhibit 256 of .412% copper in the tailings. This is taken directly from defendant's exhibit 150, Ray Consolidated Copper Company. The assay calculated on the same basis as in the other exhibit is .439. That is a close check; that is a reasonable check; it shows that the work was properly done. This other figure above, that for the fourth quarter of 1916, the given assay is .273, and the calculated is .274. That is an unexpectedly good check; we can not expect any such results in practice on the whole.

Now, my whole position in regard to the other figures presented is that they are too inaccurate for

James Wilding.

recognition as regards the Chino; that they do not show what Mr. Wicks thinks they show when analyzed.

X-Q. 12. Did you have any particular reason, Mr. Wilding, in your computation upon the Chino report, for taking the cost per ton of copper instead of the cost per pound?

A. Cost per ton—I beg your pardon.

X-Q. 13. That is, you have given on the basis of the cost per ton rather than the cost per pound of copper.

A. I have not reckoned the cost per pound of copper; I have reckoned the cost of operations, including the operating cost, the cost of smelting concentrates and the loss referred to ton of heading, not referred to pounds of copper at all.

X-Q. 14. Was there any particular reason for taking it per ton of heading, rather than per pound of copper?

A. No, there is no particular reason, only the fact that it seemed the simplest thing for me to do. However, I should say that in the other way we take into account the value of the heading in copper, which I have endeavored to eliminate, as they are so different in the two periods under comparison, that one could not reduce them to a common basis for calculation; it is almost impossible. It becomes a metallurgical surmise.

James Wilding.

RE-DIRECT EXAMINATION,

BY MR. KENYON:

7 of computation in all cases on exhibits 255, 256, 272 and 273 that you have explained to us here?

A. Yes.

MR. KENYON: Plaintiff's counsel puts the explanatory diagram of the witness in evidence, and it is marked plaintiff's exhibit No. 290.

DIAGRAM admitted in evidence marked PLAINTIFF'S EXHIBIT No. 290.

WITNESS EXCUSED.

MR. WILLIAMS: If your honor please, at the time of the proof by the plaintiff of the licensees and the returns from our licensees, the defendant requested that the original licenses be submitted for examination, and that was done. The defendant has made selections from the documents and from certain correspondence in connection with the documents, all of which were given freely to the defendant for examination. and have provided an abstract, and requests that the plaintiff put this abstract in evidence, and the plaintiff does so.

Abstract admitted, marked PLAINTIFF'S EXHIBIT No. 291.

MR. KREMER: That is introduced in view of the

P. 4726, after L. 3, insert "Re-d. Q. 15. Mr. Wilding, you used the same method"

great volume of contracts, and also in that connection I think it was suggested that a copy of your form of license, Mr. Williams, be introduced.

MR. WILLIAMS: We also offer a printed copy of the form of license of Minerals Separation, North American Corporation, the present standard form for licensees in the United States of America. And it may be added that this form of license is substantially the same as the earlier licenses granted by Minerals Separation Limited before Minerals Separation, North American Corporation assumed control.

The abstract contains the note, "old form" as referring to the old licenses of Minerals Separation Limited, and "new form" as applied to the form of license now offered in evidence.

It may be noted also that there were two forms of Minerals Separation licenses, and apparently that the line is drawn as to those two forms, rather than the new licenses of Minerals Separation, North American Corporation.

MR. KREMER: If they are all substantially the same, that is all I want.

MR. WILLIAMS: These statements, are made in lieu of evidence as to the forms, and for the purpose of simplifying and explaining what the defendant wishes to appear in explanation as to the licenses granted by the plaintiffs.

Form of license offered in evidence and admitted, marked PLAINTIFF'S EXHIBIT No. 292.

MR. WILLIAMS: I offer in evidence the Kirby mixing table "A" as exhibit 293.

Kirby mixing table admitted in evidence and marked PLAINTIFF'S EXHIBIT 293.

MR. WILLIAMS: I offer the Kirby separation tank "B" as plaintiff's exhibit 294.

Kirby separation tank "B" admitted in evidence and marked PLAINTIFF'S EXHIBIT 294.

MR. WILLIAMS: The gabbett is offered as complaintiff's exhibit 295.

Gabbett offered in evidence and marked PLAINTIFF'S EXHIBIT 295.

MR. WILLIAMS: The Cattermole upcast as complainant's exhibit 296.

Cattermole upcast admitted in evidence and marked PLAINTIFF'S EXHIBIT 296.

MR. WILLIAMS: The slide gabbett as complainant's exhibit 297.

Slide gabbett admitted in evidence and marked PLAINTIFF'S EXHIBIT 297.

MR. WILLIAMS: The bar mixer used by the plaintiff as plaintiff's exhibit 298.

Bar mixer admitted in evidence and marked PLAINTIFF'S EXHIBIT 298.

MR. WILLIAMS: The batea as plaintiff's exhibit 299.

Batea admitted in evidence and marked PLAINTIFF'S EXHIBIT 299.

MR. WILLIAMS: Mr. Greninger was requested to produce a flow sheet of the Inspiration mill showing the three types of machines used in the sections of this mill.

MR. SCOTT: I don't think it will be necessary to examine Mr. Greninger. It seems very plain.

MR. WILLIAMS: It is offered in evidence as plaintiff's exhibit 300.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 300.

MR. SCOTT: It is noted that the witness is offered for examination as to the details of the flow sheet and defendant's counsel does not care to examine him.

ARTHUR HOWARD HIGGINS, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q. 1. Were you present during the taking of the testimony of Mr. Phillips and—of Mr. Phillips as to the photographs and did you attend the magic lantern exhibition in the evening session of the court?

A. I was present on both occasions.

Q. 2. What have you to say as to the character of illustration offered by such photographs of external appearances?

A. I have examined the photographs carefully both with the naked eye and under a lens and find that they do not show a characteristic picture at all and from my point of view I cannot see that they are of any use whatever.

Q. 3. Now, a few of these photographs taken of froths produced with California eucalyptus oil. Has such an oil been used in flotation?

A. Not to my knowledge. That variety of eucalyptus is the variety that is used in medicine and it is much too expensive to use for flotation work.

Q. 4. Now, are you familiar with an eucalyptus oil that has been used in flotation?

A. Yes, with the eucalyptus amagydalena which is extensively used in Australia, and is a very efficient frothing agent.

Q. 5. What kind of oils are these eucalyptus oils?

A. They are classed as essential oils.

Q. 6. And what is their quality as to solubility when used in flotation?

A. I have examined a great many of them and found that they contained both soluble frothing agents and insoluble frothing agents.

Q. 7. Now, the oil mixture which Mr. Phillips used —so-called—was 70 per cent crude fuel oil, 17 per cent Yaryan pine oil, 13 per cent kerosene. What part of that mixture, if any, was a frothing agent?

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A. The pine oil. That contains as I say, both the soluble and insoluble frothing agents.

Q. 8. And what kind of oil is pine oil?

A. An essential oil.

Q. 9. Then he performed some experiment with pine tar oil and two experiments with wood tar oil and expressed the opinion that the oils were about the same ~~all the about the same~~ although the labels were different; what have you to say as to oils thus designated, as to whether they contain soluble and insoluble frothing agents?

A. These oils contain both insoluble and soluble frothing agents.

Q. 10. The other oils used in these experiments were kerosene in the 25 per cent kerosene experiment and as to that you have already testified, and then there was a smelter fuel oil. Have you examined that oil for the purpose of determining what it contained as to soluble and insoluble frothing agents?

A. No, I have not.

Q. 11. When that oil is used alone in proportion of five per cent as it was there used, what would you expect to obtain?

A. On that class of ore I should expect to obtain some kind of a magma.

WHEREUPON an adjournment was taken until 2:00 P. M., May 14th, 1917.

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2 o'clock p. m., May 14, 1917.

Q. 12. Mr. Higgins, were you one of the parties that visited the Magna plant of the Utah Copper Company for the purpose of viewing the operations in behalf of the plaintiff during the course of this trial?

A. No, I was not.

Q. 13. Were you one of the parties that visited the Butte & Superior plant for a similar purpose during the course of this trial?

A. Yes, I was.

Q. 14. And what did you do at that plant on that occasion?

A. I made general observations as to the method of working, and noted what results were obtained, and spent a good deal of time following different launders and pipes through the mill.

Q. 15. Were you supplied with a flow sheet at the time of this inspection?

A. Yes, I was.

Q. 16. And was that the flow sheet that was put in evidence on the Saturday before?

A. Yes.

Q. 17. I show you defendant's exhibit No. 165; was it a copy of that flow sheet that you were supplied with at the time of your inspection?

A. Yes; it was a blue print of that drawing.

Q. 18. How about the flow sheet defendant's exhibit 222; did you see that or any copy of it at the time of your inspection?

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A. No; I think the first time I saw that was on Thursday.

Q. 19. When that was put in evidence?

A. Yes.

Q. 20. And were we supplied with copies of this flow sheet when it was put in evidence?

A. No; I did not see any copies of that flow sheet.

Q. 21. Did you discover at the time of your inspection of the plant what happened to the tailings from cleaner No. 2?

A. No, I did not. I spent a good deal of time following different pipes and launders about the plant, and I found them very intricate and very well mixed up; and I do not think I could thoroughly satisfy myself about every launder and pipe within a week.

Q. 22. What have you to say as to the practice of running to waste the tailings of a second cleaner containing about 8% of zinc?

A. That is a bad metallurgical practice, and undoubtedly shows that there is some grave reason for turning out values of that grade, probably due to the fact that they wished to get rid of some deleterious material at that point.

Q. 23. Did you observe the operations of the Janney machines of the type of Nos. 1, 2 and 3 of each pyramid machine?

A. Yes, I did.

Q. 24. And, in these Janney machines were the spitzkasten plain or provided auxiliary aerating arrangements?

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A. No, those were the ordinary spitzkasten of the full width.

Q. 25. And then the spitzkasten Nos. 4, 5, 6, and 7 of each pyramid machine, did you observe in those spitzkasten any different operation?

A. Yes; those spitzkasten were narrowed down very considerably, and had the air boxes in that have been described.

Q. 26. And what was the function performed by those air boxes?

A. The functions were the discharge of air, which undoubtedly agitated the pulp in the spitz boxes, being of course additional to the agitation it had already had in the Janney machine in the agitation chamber.

Q. 27. Would you denominate that agitation by aeration?

A. Yes, I think that would be a good description.

Q. 28. And what took place in the agitating chamber; how would you describe that?

A. That is agitation by mechanical means.

Q. 29. How is the operation effected there?

A. By the production of a vortex, which is drawn down by the agitator and subsequently broken by the same agitator.

Q. 30. Would you call that aeration by agitation?

A. Yes, that is aeration by agitation.

Q. 31. Then down at the end of the plant they had what they called air cells; did you observe those air cells and their operation?

A. Yes, I did; I found those were what is com-

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monly known as Callow cells. There again air was discharged in streams through the pulp, causing agitation.

Q. 32. And what did you see on the surface of those air baskets?

A. Froth consisting of very large bubbles carrying some slimes, chiefly gangue slimes, and also some coarser mineral. The product from that operation was low grade.

Q. 33. And was that operation an operation in accordance with the patent in suit?

A. Yes, that discharge of streams of air through the pulp agitates the pulp and produces the froth.

Q. 34. And in the Janney machines, where there was first an agitating chamber and then a spitzkasten and an air chamber, was or was not the process there carried on that of the patent in suit?

A. In my opinion, that was the process.

Q. 35. Now, in the Janney machines wherein there was an agitation chamber and plain spitzkasten, what process was there carried on?

A. It was in my opinion the process of the patent in suit.

Q. 36. Now, take the operation as a whole, as you saw it at the Butte & Superior on the day of this inspection was or was not the process of the patent in suit being carried on there?

A. In my opinion it was, but in addition to that there was also the process of the solution patent. There was pine oil there which contains a soluble frothing

agent, and afterwards I saw Dr. McIlhiney remove some of this soluble material from the clear solution of the pulp.

MR. SCOTT: I move that the latter part of the answer be stricken out as absolutely irrelevant to any issue in this suit, whether the witness thinks the process of some other patent not involved was or was not being carried out.

THE COURT: Please read the question and answer.

(Question and answer read).

MR. WILLIAMS: May I say a word before your honor rules. This operation at the Butte & Superior examined by this witness was an operation resembling the operation of the Ray, the Chino and the Utah that were said to represent the prior art, all of them were characterized by the use of a soluble frothing agent, and the explanation of these operations lies in that fact. Now, the witness is explaining the phenomena that were exhibited to him by the defendant. Is the witness to be restrained from full explanation?

THE COURT: Well, I think he went away beyond the question. His answer is not responsive. He was asked if it was the process of the patent in suit and he says yes and now he adds considerable about some other patent, which was not necessary to qualify his answer as given. It seems to me it is not a qualification but it is a mere addition. As the question and answer stand all after the words "in my opinion it is" may be stricken.

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Q. 37. MR. WILLIAMS: Was there in the operation exhibited to you by the defendant the carrying out of any other process than the process of the patent in suit?

A. Yes, there was.

MR. SCOTT: I object to that question too because other processes are not involved in this suit and it seems to me it is entirely irrelevant and immaterial. They may be practicing one hundred processes there.

THE COURT: Well, to a certain extent, yes, as far as the mere issue is involved. It is a part in conjunction with the processes in suit so that it may be fully laid before the court, especially if we are to go up there and view these operations I think he ought to be allowed to state what he saw. The objection is overruled.

Q. 37½. MR. WILLIAMS: What other process was being carried out with the process of the patent in suit?

A. Pine oil was being added to the pulp in mixture of oils that were fed into the pulp at the discharge from the tube mill. Pine oil contains both soluble agents and insoluble agents, and in my opinion the use of pine oil would make the process both that of the patent in suit and the solution patent.

MR. SCOTT: I repeat my original objection on the same ground.

THE COURT: Yes, the objection will be overruled.

MR. SCOTT: Exception.

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Q. 38. MR. WILLIAMS: What frothing agents were present in the operations of the defendant, those exhibited to you?

A. Pine oil, both the insoluble pine oil and the soluble pine oil.

Q. 39. About the other oils that were used, fuel oil and kerosene?

A. In small quantities fuel oil and kerosene are useful in the process in the patent in suit, chiefly for the purpose of preventing the coarse mineral from falling out of the froth. Used over and above that quantity, they are inert and may even be harmful to the process.

Q. 40. What is the effect of the use of a soluble frothing agent in conjunction with these large quantities of such oils as kerosene and fuel oil?

A. The addition of a soluble frothing agent causes the detrimental effects of the inert oils such as kerosene and Jones oil and fuel oil, to be more or less overcome.

Q. 41. When employing soluble frothing agents do you or do you not obtain as stable a froth as when you employ oily frothing agents in the manner of the patent in suit?

A. If the ore treated happens to be moderately coarse, then the oily agent gives a very much more stable froth than the soluble frothing agent; but if the mineral is ground sufficiently fine there is very little difference in the stability of the two froths.

Q. 42. And what is the effect of adding a small

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quantity of these oils which you have characterized as inert to a soluble frothing agent?

A. That prevents the falling out of the coarse particles from the froth. Only a very small quantity is necessary for that purpose and above that quantity the oil remains inert until it gets in such large quantities that it becomes harmful to the process.

Q. 43. Did you find in these operations exhibited to you at the Butte & Superior any operations of the prior art, Everson, Kirby, Froment, or California Journal, or any other?

A. No, I did not. The fact that they were using the Janney machines, which were invented long after the patent in suit, makes it impossible for the processes of the prior art to be carried out in the Butte & Superior mill.

Q. 44. Was this process being carried out for the purpose of any of these prior art patents or disclosures?

A. Not in my opinion.

Q. 45. Did it affect the result of any of these prior art disclosures or patents?

A. No, it did not.

Q. 46. Now, there has been evidence in this case of other operations at the Arthur and Magna plants of the Utah Copper Company, at the Ray Consolidated and at the Chino. Did you hear the testimony in regard to those operations?

A. Yes, I did.

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Q. 47. Were these operations operations of the prior art?

A. Not in my opinion.

Q. 48. And why not?

A. The processes were not carried out in machines disclosed in the prior art or according to the disclosures of the prior art.

Q. 49. Have you ever obtained mineral froth by the use of kerosene alone?

A. No, I have not.

Q. 50. By what name is kerosene known in England?

A. Paraffin oil or simply paraffin.

Q. 51. You mentioned two especial instances wherein you had obtained a mineral froth with petroleum oils. What were those exceptional instances?

A. One of them was the use of the material known as petrol which is used for motor cars in England and the other was in the use of a heavy lubricating oil such as is used for valves, and known as cosmos oil.

Q. 52. And is petrol in England the equivalent of gasoline in America?

A. Yes, it is the trade equivalent. It is rather lighter.

Q. 53. Did you examine these oils at the time that you made these experiments, for the purpose of determining the purity?

A. No, I did not.

Q. 54. Now, as to the oil that is described in the California Journal of Technology, can you state

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whether or not that is a mineral frothing oil.

A. That is not; that is the Elmore oil; that is not a frothing oil.

Q. 55. When you carried out your experiment on Saturday, repeating the operations performed by Mr. Phillips with 25% of kerosene, did you supply a specimen of that kerosene to defendant's representatives?

A. I think that was done; I gave instructions for that to be done.

Q. 56. And was a larger specimen called for and supplied?

A. Yes.

Q. 57. Now, are you ready to perform an experiment with Butte & Superior ore received from the defendant during March, 1917?

A. Yes, I am.

Q. 58. Is this the experiment that you started to perform and did not finish?

A. Yes.

Q. 59. Can you explain why the other experiment failed, if that is the fact?

A. Yes, the fact is that it failed. During the operation I noticed there was a quantity of sulphuretted hydrogen evolved, and it is well known that in the agitation froth process sulphuretted hydrogen is very detrimental. The experiment had previously been successful three times in succession. I have repeated that since. The ore shows, in spite of the most thorough mixing, a very patchy nature; some samples evolving more sulphuretted hydrogen than others. In order to

get over the difficulty of getting an unusual quantity of sulphuretted hydrogen in that manner, I shall add to the pulp some copper sulphate, which will destroy the sulphuretted hydrogen evolved.

Q. 60. Are there other methods than this of preventing the deleterious effect of sulphuretted hydrogen in the agitation froth process?

A. Yes; any of the well known heavy metals will precipitate it, or it can be destroyed by an oxidizing agent, such as a permanganate, or anything that will react with it, such as sulphur dioxide.

Q. 61. The operation of preventing it is what sort of an operation?

A. It is a chemical operation which is well known.

Q. 62. This copper sulphate that you will use came from where?

A. It is part of the sample that we took at the Butte & Superior plant on the 29th of April.

Q. 63. Please describe the experiment which you are about to perform.

A. 2000 c.c. of water at 40° C.; 500 grams of Butte & Superior ore crushed to 65 mesh, the sample being received during March, 1917; 5.8 c.c. of sulphuric acid, and 3.4 c.c. of copper sulphate solution. That will be agitated for one minute, to make sure that the copper sulphate has had a chance to destroy any sulphuretted hydrogen evolved; then we will add .55 c.c. of oleic acid and agitate again for about three minutes, the speed of the agitation being between 850 and 900 revolutions per minute.

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Q. 64. In what machine will you perform this experiment?

A. In the slide Gabbett machine.

(Machine run for a certain period.)

Q. 65. What have you to say as to the result of this three minute agitation?

A. I have already said that this ore is very patchy, and in spite of the most thorough mixing one can not predict what will happen to it. The corrective is easy to apply, but one can not tell how much it will require. The result there is, there is still a smell of sulphuretted hydrogen coming from the pulp.

Q. 66. Did you smell it at the conclusion of the operation to detect it?

A. Yes.

Q. 67. What do you propose to do?

A. I will put in some more copper sulphate solution, 3 c.c.

Q. 68. Of the copper sulphate solution?

A. Of the same copper sulphate solution.

(Machine run again for a period.)

THE WITNESS: I will put in some more copper sulphate.

Q. 69. What was the result when the agitation was stopped the second time?

A. About three eights to one half an inch of foam which was readdily broken.

MR. SCOTT: In other words, commonly speaking, it wasn't of any use?

A. Not much.

MR. KENYON: Plaintiff's counsel has made the interlineation in the supplemental bill, page 7, third line from the bottom after the word "disclaimer" of the words "as well as the invention or inventions of claims 1, 2, 3, 5, 6, 7 and 12 of said letters patent," also in the next line the letter "s" at the end of the word "continue" changing it to "continues" and the same has been initialed in the margin by the clerk.

MR. KREMER: The defendant, after amendment to the supplemental bill of complaint by counsel for the plaintiff, with permission of court, amends the answer to the supplemental bill of complaint in the following particulars: by inserting in line 17 of page 5 of said answer to the supplemental complaint after the word "disclaimer" the following "or has employed processes of concentrating powdered ore embodying and containing the alleged invention or inventions of claims 1, 2, 3, 5, 6, 7 or 12 or any or either of them or at all of said letters patent"; and after the word "continues" in said line the following: "or continues". These interlineations so made have been initialed as follows by the clerk: "G. W. S. by H. H. W. 5 line 14 line 17."

THE COURT: It will be permitted.

Q. 70. MR. WILLIAMS: What about the result of the third agitation for three minutes following the addition of copper sulphate?

A. It has improved the results slightly. I think if we had sufficient of this percipitant the result would be quite satisfactory. It is only a matter of

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time, adding that same material and continuing the agitation.

Q. 71. What about the temperature of the mixture?

A. The temperature has fallen to 35.

Q. 72. And you aimed to carry on the operation at what temperature?

A. At 40° C.

Q. 73. And it is now 35° C.?

A. It is now 35.

Q. 74. And you first agitated for three minutes and then after stopping you added three c.c. of copper sulphate and then you agitated for another three minutes and then stopped and added 3 c.c. more of copper sulphate, is that right?

A. Yes, that is right.

Q. 75. So that there were three periods of three minutes each agitation?

A. Yes.

Q. 76. And you say there has been a gradual improvement?

A. Each addition of copper sulphate has shown an improvement.

MR. SCOTT: May I ask Mr. Higgins how he would characterize this last float with regard to efficiency as to whether you have anything like a satisfactory recovery in that float there?

A. No, that is not a satisfactory recovery in it. Shall I continue with the copper sulphate.

Q. 77. MR. WILLIAMS: Now, would you pre-

fer to repeat this with the drop in temperature that you have or go on with another experiment with the ore that you received at an earlier date?

A. If we take a new lot of the same ore we have still got the same difficulty. We cannot predict what amount of copper sulphate that wants, although this sample has been very thoroughly mixed we don't seem to be able to get a representative mixture of the material and each sample that we take out requires a somewhat different quantity of copper sulphate. That is a condition I never have observed before in any of the samples I have handled.

Q. 78. I suggest that you carry on the experiment now with the older ore which you received from the Butte & Superior?

A. Yes, that can be done.

Q. 79. And what will you do with this one?

MR. SCOTT: That is a slide machine and I suggest that we slide it off and take samples for assay.

THE WITNESS: If you wish to do that, Mr. Scott, I think we will add some more copper sulphate.

Q. 80. THE COURT: How much oil per ton?

A. Two pounds of oleic acid per ton.

Q. 81. THE COURT: What is that percentage?

A. .1 per cent.

MR. WILLIAMS: Can you heat this mixture as it is in the vessel?

A. I can, yes.

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Q. 82. Suppose you do that and then go on with the other experiment.

MR. SHERIDAN: I would like to have your honor notice the overloading there.

THE WITNESS: I should like to make the remark that what Mr. Sheridan calls overloading is simply some of the mineral being dropped out of the froth falling down slightly through the flocculated slimes.

(Witness perfoms an experiment.)

Q. 83. MR. SCOTT: What temperature was the pulp raised to when you just tried it with the thermometer?

A. 39° C.

MR. WILLIAMS: What has been the result of heating the pulp, adding 3 c.c. of copper sulphate and repeating the three minute agitation?

A. There was about the same amount of froth floating on the surface but not sufficient to make any recoveries to speak of.

Q. 84. Now, describe the experiment that you are about to do.

A. I am about to take 500 gms. of Butte & Superior ore received by us in 1912 or 1913, 2000 c.c. of water, at about 40° C., 5.8 c.c. of sulphuric acid, and add to that .55 c.c. of oleic acid which is two pounds per ton and agitate three minutes at about 850 to 900 r. p. m.

Q. 85. What is the result of the operation that you have now carried on?

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A. That operation is successful; there is about an inch and three-quarters of heavy mineralized froth on the surface.

Q. 86. What is your judgment as to whether or not that is a good recovery?

A. The tailings appear very clean; I think it is a good recovery.

Q. 87. BY MR. SCOTT: Do there appear to be any pendant masses at the bottom of the froth that you have just made?

A. The bottom of the froth is somewhat irregular.

Q. 88. BY MR. WILLIAMS: What is the significance of that irregularity?

A. I don't see that it has any significance whatever. It is probably due to the compression of the froth of its own weight since it rose to the surface of the pulp.

Q. 89. THE COURT: A little bit troubled interface?

A. Yes, it is an interface all right. In this case it is not an interface of oil and water; it is an interface of air and water.

Q. 90. BY MR. WILLIAMS: Do you usually succeed in getting froths without pendant parts with oleic acid?

A. No, they are usually a little bit like that. It shows more holes when the froth is heavily mineralized. When the froth contains less mineral it is usually much flatter. It comes flat on the upper sur-

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face and on the under surface, as it did in this one that failed.

Q. 91. Now, what do you propose to do with the result of this last experiment which has produced this froth that you have described?

A. I understand you wish me to add more oil to that.

Q. 92. What will be the result of adding more oil?

A. The froth will sink, and it will form granules.

Q. 93. How much more oil will you add?

A. 20 c.c., so that the total oil will be 3.7%.

(Machine run for a period.)

Q. 94. Now, describe the result of this last operation upon stopping the agitation.

A. A few granules came up to the surface, carried there by air bubbles, and on reaching the surface the air bubbles burst, leaving a few granules swimming on the surface, not enough to completely cover the water. A lot of the granules, on the bursting of the air bubbles, sank to the bottom, and a large number of granules can be seen on the bottom of the jar, through the window.

Q. 95. What kind of float is that on the surface, to the extent that it is there?

A. It is a skin float or surface tension float. These few minerals are swimming on top of the water just the same as a greased needle would swim there.

Q. 96. Is there any froth?

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A. No, there is no froth.

Q. 97. Can you separate a few of those granules?

A. I would like to run the machine at a much higher speed, to show that the effect of high speed makes no difference in the formation of the granules.

Q. 98. What speed will you run it at?

A. I think we can get it up to 1500.

(Machine run for a period.)

Q. 99. Now, how long did you agitate it at this higher speed?

A. One minute and the result was just the same —that is some speed over 1500 revolutions per minute, but the result was just the same as at the lower speed. Now, I think we can run out some of the granules. (Removing granules from the Gabbett.) That shows both the granules and the sand.

Q. 100. How effective has the granulation been?

A. The granulation is very good, seems to have taken up practically the whole of the mineral.

Q. 101. Now, as to the first example with the recent ore of the Butte & Superior, what is your personal observation as to the condition of the material that you have used?

A. Gas is still being evolved from it.

MR. WILLIAMS: I think we will not take the time of the court further in this experiment, Mr. Higgins. The direct examination is closed.

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CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 102. I think you said, Mr. Higgins, this morning that the photographs which were made by Mr. Phillips did not exhibit any of the characteristics, I think you said, of the froth present. Now, what are the characteristics that you have in mind?

A. The appearance of the froth in its composition. The color is also characteristic, the glistening of the mineral and so forth. I was unable to detect those from those photographs.

X-Q. 103. The glistening of the mineral, the color and what else?

A. Also the conformation of the bubbles.

X-Q. 104. Those are the things that define the difference between what you call an air froth and an oil froth?

A. No, I never said so.

X-Q. 105. Well, what difference does it make whether is is—whether these characteristics are shown or not if they don't have anything to do with the difference between the two floats you have defined? What are those characteristics that would tell us that difference?

A. The photographs do not show anything to me because as I say I cannot see these differences that I looked for.

X-Q. 106. You mean the three you have just named?

A. Yes, the amount of oil and that kind of thing. If you are considering the differences between an air froth and a magma it is necessary not only to see the color and shape and form and that kind of thing, but also to know something about the oil—about the amount of oil it contains.

X-Q. 107. Does the ability of this float to carry a metalliferous mineral have any bearing upon whether it is what you call an air froth or a magma?

A. Referring to any kind of float?

X-Q. 108. Well, I am referring to the kind you have mentioned, the air froth as you call it, and the magma or oil froth?

A. The ability of an air froth to carry mineral depends entirely on the ~~ore.~~ air The oil is not responsible at all for the flotation of the mineral, as far as its buoyancy is concerned. The ability of a magma to carry mineral depends sometimes on the amount of oil and occasionally you can replace some of that by bubbles of gas of one kind or another so that in that case of course the air is not the efficient carrying agent although it may assist the magma in floating.

X-Q. 109. What is it, in what you call an air froth?

A. The carrying power or buoyancy does not come from the oil. Two pounds of oil to the ton of ore having a specific gravity of .9 would be able to float about two-tenths of a pound of mineral.

X-Q. 110. About two-tenths of a pound?

A. Yes.

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X-Q. 111. Well, suppose you had twenty pounds of oil, how much mineral would that be able to carry?

A. Twenty pounds per ton of ore, of course that would carry ten times as much, as far as buoyancy is concerned.

X-Q. 112. How much would that be? Two pounds?

A. Yes.

X-Q. 113. So that with twenty pounds of oil to the ton of ore you can only account for the flotation of two pounds by the buoyancy of the oil?

A. That is of course assuming that the whole of the oil goes to the mineral and floats upon the surface.

X-Q. 114. Giving the oil every possible credit for flotation?

A. Yes.

X-Q. 115. Which of course is rather overstating it?

A. Yes.

X-Q. 116. But even with twenty pounds of oil per ton of ore you cannot by any possibility, theoretically or otherwise, float more than two pounds of material?

A. As long as you refer only to the buoyancy of the oil, that is correct. If you use the oil in the same way, apply the efforts of a skin surface float, twenty pounds of oil to the ton would of course make you a totally different showing. You would not reduce the buoyancy of the oil.

X-Q. 117. Well, now, is the definition between

what you call an air froth and a magma or oil froth, does that reside in the relation between the buoyancy supplied or possibly supplied by the oil and that supplied by the air or other gas?

A. In part.

X-Q. 118. In part?

A. As I said before, some of the buoyancy may be due to the oil. You may enhance that buoyancy by entangling air in the mass.

X-Q. 119. I will ask you another question: Is the difference between what you call an air froth and an oil froth or magma a difference in the technical utility, having a difference in the amount of mineral that is recovered in an acceptable form, or does it reside in something entirely separate and apart from any consideration of utility but merely something within the realm of scientific observation?

A. My observation leads me to the opinion that a magma has a very different utility to an air froth. One can obtain a magma in a small vessel such as these measuring vessels, making it look very nice and apparently carrying large values, whereas when you come to separate these in a large scale, the viscosity is not sufficient to hold it over the surface it has to travel it over and you get very great losses. The scientific difference I don't know much about that.

X-Q. 120. Well, I don't know that I understand your answer. Do you mean that you think that the difference between the air froth and the oil froth

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or magma as we call them is a difference in their respective technical utilities?

A. It is not only a difference in their properties but in their technical utility as you suggest.

X-Q. 121. Well, how useful does a float have to be to be an air froth? Can't you give it in terms of recovery or efficiency? If that is what the difference is it ought to be something exact?

A. No, I haven't had any technical experience working with magma and I have got no figures to use by way of comparison. The magma floats I gave up long since as being quite useless although the use of a soluble frothing agent helps very considerably, to my mind they are not sufficiently valuable to spend any time working with them.

X-Q. 122. In other words you cannot define the difference upon the basis of utility? Is that what you mean to say?

A. If you take exactly the same condition you will find that as a rule when you get a magma you get a less useful result than when you get a froth, but I cannot compare one magma with another air froth. You might compare a fair magma with a froth of that nature, which is more or less useless (referring to a froth in one of the experiments recently performed).

X-Q. 123. Well, can't you state this in the quantity of reagents used? Can't you state it somehow?

A. The quantity of reagents does not decide the difference. It is a matter of process and results.

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X-Q. 124. So that by being told the quantity of reagents—and by "reagents" I mean the oil, speaking generically—by being told that you are not able to determine in advance whether you are going to have this so-called air froth or the oil froth?

A. Within certain limits. If I know the conditions that are going to be used, for instance if you tell me you were going to use 300 per cent of oil to the ton and you were going to roll it over, I could tell what kind of results you would get.

X-Q. 125. Suppose I would tell you I was going to use 2 per cent of oil?

A. Then I can't tell you because I don't know what conditions you are going to use it under or what the many large variants are that enter into the process, what kind of result it is going to ~~get~~ give.

X-Q. 126. Suppose I tell you I was using—I was going to use nine-tenths of a per cent of oil. Can you tell me then without knowing all of these things?

A. I can't tell you unless I know something about the condition and the way the process is carried out.

X-Q. 127. Then whether the amount of oil is less than one per cent or more than one per cent, it is impossible to tell whether you are going to get this air froth or not, without having additional facts or making an investigation?

A. In my opinion it is necessary to see the process and examine something of those conditions that make the difference in the results for the use of that percentage of oil.

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X-Q. 128. I think the question related to either over or under one per cent, did it not? If you are under a misapprehension I will state the question again.

A. I would like to state I was under the apprehension that you mentioned about .9 to 1.1 in your preceding question.

X-Q. 129. Yes, something either side, either over or under one per cent. You stated a while ago that the operations which you saw in the Butte & Superior mill could not be the processes of the article in the California Journal of Technology because the process was carried out in Janney machines which were not invented until some years after the article was written. Now, how is it that the process of the patent in suit can in your opinion be carried out in that machine when the machine was not invented until some years after the patent in suit was drafted and granted?

A. I believe that is a matter of law.

X-Q. 130. You mean it is a matter of law regarding the process of the patent in suit but not regarding the California Journal?

A. I believe that is a matter for the court to determine whether, a process can be carried out in a modern apparatus and still infringe the patent.

X-Q. 131. What I want to find out from you, do you know of any facts, technical, scientific or otherwise, that would prevent the process of the California Journal being carried out in Janney machines any more

than it would prevent the process of the patent in suit being carried out in Janney machines?

A. No, I know of no facts of any kind to prevent anyone from making an improvement on any patent.

X-Q. 132. Or on any publication, I suppose?

A. Or on any publication.

X-Q. 133. If you used a soluble frothing agent, purely soluble frothing agent, without any insoluble admixture, and otherwise follow the directions of the patent in suit, would you be practicing the process of the patent in suit?

A. In my opinion if you use a total or completely soluble agent you would not be using the process of the patent in suit.

X-Q. 134. Is there such a thing in your opinion as an insoluble frothing agent?

A. Yes.

X-Q. 135. What are some of them?

A. Oleic acid is one of them. That is the example given in the patent.

X-Q. 136. Have you seen the Janney machine in other places than in the Butte & Superior mill used for carrying on the process described in the patent in suit?

A. No, I have not.

X-Q. 137. Did you ever see the apparatus described in the patent in suit and illustrated there used in practice in this country?

A. No, not in this country or in practice.

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X-Q. 138. Where did you see it, if you have seen it?

A. The apparatus shown in the drawing?

X-Q. 139. In the patent in suit, including the cone Gabbett and the open launder for taking the pulp to a settling affair consisting of three pointed boxes?

A. That was in use in the laboratory in London.

X-Q. 140. Was it ever in use anywhere else?

A. Well, it was in use in Australia, except that the three boxes were separate and the pulp ran from one to the other. The same principle was adopted, though.

X-Q. 141. Is it in use anywhere in the world now to your knowledge?

A. Not to my knowledge. The necessity of having three spitz boxes has gone absolutely with the much finer crushing that is now used.

X-Q. 142. How lately to your knowledge was such an apparatus as that described in the patent in suit and illustrated therein used in operation for ordinary commercial purposes?

A. To my knowledge not since 1908.

X-Q. 143. And was the one you saw then just like the one described in the patent in suit?

A. No, it was the one that I spoke of in Australia, with the differences in respect to the three boxes being separate, instead of being joined.

X-Q. 144. It had an open launder, did it?

A. Yes, that had an open launder.

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X-Q. 145. You commented upon the experiment performed by Mr. Dosenbach in which he made a froth, then by means of slower agitation caused the metalliferous mineral to sink, and by more rapid agitation raised it as a froth, repeating that cycle several times. In your comment you said that the material which Mr. Dosenbach caused to sink and which he separated in an up-cast as described in the Cattermole patent, it—You said that the material did not consist of granules, that it consisted of what?

A. I think they were simply separate pieces of coarse material with the fine material stuck here and there over them, but they were in no sense granules. A granule is a nice rounded mass, quite compact, and this appears to me to be a totally different thing. The action that I showed here shows the difference in the properties of granules and these mineral agglomerates, if it is an agglomerate, and I am not sure about that, even; it shows that it has different properties.

X-Q. 146. This material which was brought together and sunk by Mr. Dosenbach's experiment consisted of separate particles brought together, did it not?

A. You mean brought together in a froth?

X-Q. 147. Well, in conglomerations.

A. If you mean by conglomeration, one particle stuck to another yes, but an agglomeration to my mind means more than two particles; it means several.

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X-Q. 148. You think there were just two particles in each one that Mr. Dosenbach formed?

A. I have not made a close enough examination to answer, but in my mind they were not granules.

X-Q. 149. You could see them, couldn't you, in the up-cast?

A. I saw a mass of stuff coming out of the bottom of the up-cast, yes.

X-Q. 150. And you know that all of those were not single individual particles, the same as they came from the grinding operation, don't you?

A. I examined them under the microscope, and each one of them showed perfectly sharp faces, with what appeared to be a little dust on the corners now and again.

X-Q. 151. What useful property has a granule with more particles in it—the larger granule—than these made by Mr. Dosenbach? Mr. Dosenbach's granules sank in the up-cast, didn't they?

A. They did, but they are not granules.

X-Q. 152. That is their value, isn't it, that they sink in the up-cast so you can separate them?

A. That is not the result of the Cattermole process, that was shown in court; that was not the Cattermole process that was shown, and before you can take a position where you can say they are granules, they must be different from what he showed. I think I pointed out, on repeating the experiment, where the granules were agitated under high speed, and a little

higher than Mr. Dosenbach used, and yet they did not float any more than they did under the low speed.

X-Q. 153. How did you perform the Cattermole experiment in court?

A. I got Cattermole granules in a cone mixer and separated the material in an up-cast.

X-Q. 154. Wasn't that just exactly what Mr. Dosenbach did?

A. Mr. Dosenbach went through the same operations as far as I recall, but he did not get the same results.

X-Q. 155. He got the mineral separated, didn't he?

A. Well, you can separate mineral by separating it on a placque, but that is not the Cattermole process.

X-Q. 156. Did Mr. Dosenbach separate it in an up-cast?

A. Yes.

X-Q. 157. And that is what you did?

A. Yes.

X-Q. 158. Then what is the difference?

A. The difference was that I made granules and he did not.

X-Q. 159. You mean that you got a little larger agglomeration of mineral than he did?

A. I was giving an illustration of the Cattermole process, which I think was very successful; Mr. Dosenbach's operation was not the Cattermole process.

X-Q. 160. Then we will go back to the same sub-

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ject again. You think Mr. Dosenbach did not agglomerate the metalliferous mineral particles into aggregates, did he?

A. I did not say it was not aggregates: I said there was probably some agglomeration, but they were not granules.

X-Q. 161. What is the difference between what you call granules and these agglomerates which you saw Mr. Dosenbach make?

A. There is just as much difference as there is between a house, which is firmly built together of brick and mortar, and a loose pile of brick. The pile of brick represents an agglomerate, but when you build it into a wall firm and smooth, a nice rounded mass, then it becomes a granule.

X-Q. 162. You will admit, won't you, that the agglomerates that Mr. Dosenbach made were large enough and firm enough to sink in the up-cast, while the slime was carried over the top, don't you?

A. The mineral did sink at the time, but that depends a great deal on the difference in size between the mineral and the gangue. One could take such an amount of mineral of fair size, and put it in with sand —I am giving you an example now, I am not suggesting anything—and you could, by using those sizes, separate them in an up-cast, exactly the same as in that experiment. Unless we have a screen analysis which tells us the distribution of the metal and sand, it is quite impossible to say whether that was due to agglomeration of the mineral or not.

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X-Q. 163. You got a sample of what Mr. Dosenbach used in that experiment?

A. Yes.

X-Q. 164. You did not find anything to indicate that that could have been classified that way forming it into granules?

A. I have not examined it from that point of view; I did not know that you would want to know that.

X-Q. 165. Do you think, honestly, that that was a simple act of classification, independent of the Cattermole process, that was carried on by Mr. Dosenbach?

A. I say I honestly believe there were some agglomerations there, as far as some of the particles went; but as far as other particles went it was not an agglomeration, and it was not the Cattermole process.

X-Q. 166. How about the fact that upon greater agitation the mineral froth as a froth appeared, and under another kind of agitation it sunk with the same quantity ~~quality~~ of oil and mineral?

A. That was because the mineral was not agglomerated. He had not there sufficient oil to attach the mineral particles to each other to make nice granules, and the oil was not able to get at the mineral and attach itself to it.

X-Q. 167. The mineral was separated in an upcast, and under one kind of agitation it sunk, and under the other it was raised?

A. That was the peculiarity of the experiment.

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X-Q. 168. It shows what difference the difference in the agitation made, didn't it?

A. In that particular experiment, yes. When we go to work and make the froth, and afterwards run the agitator very gently, about 300 revolutions, that has the effect of centrifugal separation. You have taken out the air and the mineral could not do anything else than sink.

X-Q. 169. That is when you are agitating slowly?

A. Yes.

X-Q. 170. You get a violent centrifugal action when you agitate slowly, but you do not get it when you agitate more rapidly?

A. No; when you do it more rapidly you have the air coming through the pulp all the time in the form of small bubbles.

X-Q. 171. The air comes in faster than the centrifugal force can throw it out?

A. When it is going on high speed you get a fresh supply of air every time it turns it around.

X-Q. 172. And when you are going at low speed, what happens?

A. Then you do not; if you run it sufficiently slowly, you get no air at all.

X-Q. 173. I suppose at the low speed the centrifugal action throws the air off because the air is so much heavier than the mineral?

A. No; I don't think I suggested such a thing.

X-Q. 174. If I remember right, Mr. Higgins, you

said that you used 900 r. p. m. for the Cattermole process and the same speed, 900 r. p. m. for the process of the patent in suit. My recollection is correct, is it not?

A. Yes, that was about the speed that we used I think I said so.

X-Q. 175. You made no distinction as to revolutions per minute of the agitation between the two?

A. No. The patent says that they are carried on —the patent in suit is carried on in the same manner as—in the same agitators as in the processes previously mentioned, which are the two Cattermole processes.

X-Q. 176. Then it is hardly necessary for me to ask you whether you agree with Dr. Leibmann who was the expert witness in the Hyde case when he said: "I believe that 500 to 600 revolutions are quite sufficient for the Cattermole process, but I believe that at least 1200 r. p. m. are necessary for the process of the patent in suit in the same apparatus."

MR. WILLIAMS: I presume that in view of the fact that that evidence is in the record it may not be objectionable to endeavor to get it in again, but it does not seem to me that the question is quite a warranted question and I object to it.

THE COURT: Well I think you may ask the question. This witness has performed some experiments at various speeds and another expert for the same party has expressed his opinion that different

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speeds will serve or are necessary. Now, I think to arrive at this witness' opinion, he may ask the question. The objection will be overruled.

A. Without specifying exactly what the conditions were under which these processes were to be carried out, I do not agree with the statement as it stands. If you say that the Cattermole can be carried out at 500 or 600, I think that is quite true. It is also true that the Cattermole can be carried out at the higher speed. Further, it is quite true that the agitation froth process can be carried out at one or two thousand. It is likewise true it can be carried out at less. Now, if you compare two speeds under different conditions you may get exactly the same results; and the froth in one case—or you may get a froth in one case and get granules in another case.

X-Q. 177. At exactly the same speed?

A. Yes, at the same speed, but it may take some differences in other conditions, such as the time or the temperatures or the size of the granules, something of that kind. There are so many conditions that alter these facts that one cannot really give you a flat rate on that, you have to consider so many things at the same time.

X-Q. 178. You say that with the same amount of oil the different speeds might give you the different results, according to other conditions?

A. Oh, I hope I did not. I did not mean to say that.

(The witness' answer read as follows: "Without specifying exactly what the conditions were under

which these processes were to be carried out, I do not agree with the statement as it stands. If you say that the Cattermole can be carried out at 500 or 600, I think that is quite true. It is also true that the Cattermole can be carried out at the higher speed. Further, it is quite true that the agitation froth process can be carried out at one or two thousand. It is likewise true it can be carried out at less. Now, if you compare two speeds under different conditions you may get exactly the same results; and the froth in one case—or you may get a froth in one case and get granules in another case. X-Q. At exactly the same speed? A. Yes, at the same speed, but it may take some differences in other conditions, such as the time or the temperature or the size of the granules, something of that kind. There are so many conditions that alter these facts that one cannot really give you a flat rate on that, you have to consider so many things at the same time.")

X-Q. 179. And no one of these many things is guiding in itself, as to the result, is it?

A. Not absolutely, no. They all work together, one acting one way and another acting another way.

X-Q. 180. The final effect is a sort of a resultant of all these different forces that are at work, and conditions?

A. Yes, that is true. One cannot take the amount of oil or the fineness of grinding or the temperature or the time of agitation without considering each at the same time. An alteration of one may make an alteration of another. That is particularly true with the Cat-

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termole process; more so than of the agitation froth process.

X-Q. 181. When you performed that experiment with the Elm Orlu ore about which you testified in the Hyde case, using 3.6 per cent of cotton seed oil, I think it was?

A. Yes.

X-Q. 182. You obtained a float which you described as follows: "In about three minutes the plant had settled into a permanent condition. The float on the first spitzkasten was copious, being about one inch to an inch and a half deep and though oily in appearance, when closely examined, did not differ in appearance from the usual agitation froth at a distance of a few feet." Now, what is it aside from appearance, what is it—was it an air froth—was it an agitation froth as it was called at the time of the Hyde suit, now called an air froth, or was it one of these magmas that you spoke of or oil froths?

A. I think I went on and gave some further description.

X-Q. 183. I will read the rest: "These floats were exceedingly dense and occasionally fell down in large masses. The tailings contained some granules and did not indicate a satisfactory recovery." Then you give the assay.

A. As far as I remember that froth, it was chiefly floating granules entangled with air and the very fact that every now and then the froth would suddenly

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sweep in to a great vortex and tumble down and clea~~ned~~n almost the whole spitzkasten showed it had very different properties from an air froth. As to whether it was a magma or not I do not feel quite certain. I think that depends largely on the definition of magma. I think in my opinion I should say it was not exactly a magma but a collection of floating granules.

X-Q. 184. Well, how many of these kinds of flotation—of floats have we now? We have got a magma, an oil froth, an air froth, and what is this last one?

A. These floating granules.

X-Q. 185. Now, a floating granule an inch to an inch and a half deep, what makes them float?

A. Largely the entrapment of the air. You see if you spread it out on a large surface, for instance, such as Mr. Chapman did in London with the same quantity of oil, that was run out over a very much larger surface and then of course the air was given a chance to escape, which it did readily and left nothing floating worth speaking of. I believe the recovery in that case was something like eight or nine per cent. That floating is caused largely by the mechanical prevention of the escape of gas or air.

X-Q. 186. What do you mean by "the ~~M~~mechanical prevention"?

A. Well, it is something like enclosing it in a cork.

X-Q. 187. In a what?

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A. In a cork, bottling it up.

X-Q. 188. Well, what bottles it up?

A. The layer of granules on the top.

X-Q. 189. The granules enclose the air bubbles, you mean?

A. Yes.

X-Q. 190. Coat them?

A. No, entangle them.

X-Q. 191. There is a difference then between coating them and covering them?

A. Yes, there is a distinction there.

X-Q. 192. Let us have that difference so we will understand it?

A. Just the same distinction there is between the coating of air bubbles in the agitation froth process and what you may ~~mean~~ call the coating of the air bubbles in the magma. In one case it is an entirely different thing from another case. In the first case you have the attachment direct to the air and in the other case it is more or less coated because it cannot escape quick enough. In one case it is more or less permanent and in the other it is temporary.

X-Q. 193. Well, aren't you rather explaining this in terms of something else? I want to know what the difference between the coating an air bubble is, with mineral particles, and covering it. Now, you say one is like a magma and the other is like an air froth. I am trying to find out the difference between these two things. What is the difference between coating a bubble with mineral and covering it was a mineral, with-

out referring to these other things in definite terms?

A. The coating of course is a term well known to the art and it is applied to coating such as you get in the agitation froth processes where the air is directly attached to the mineral. You get what appears to be a little cell of metalliferous mineral bent round into a curved surface. Of course that might be called "covering" if you like to use that as a synonym, but that is not the same thing as taking an air bubble and pouring oil over the surface. For instance, you can take the agitation froth here and put a layer of grease over it but that would not be the same thing. That would be covering it with grease, but it would not be coating it.

X-Q. 194. Tell these things apart when you look at them, can you? If I have a series of them here made with oil running up from one-tenth by tenths up to three per cent, of oil, can you draw the line where one of these things leave off and the other begins?

A. I might and I might not.

X-Q. 195. Most likely not.

A. If I knew something about the ore and the way it behaved and the oil you put in I think I could tell you.

X-Q. 196. If you knew how much oil I used?

A. I should have to examine the conditions. As a result of the examination I think I could tell you where it went.

X-Q. 197. You never did such a thing, did you?

A. No, it isn't exactly a fair thing to ask a man to

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do because these graduations where one thing may occur at the same time as another would be very difficult to decide. Still I know of one test by which I might decide that matter.

X-Q. 198. You saw the large machine work upstairs, did you in the grand jury room, one of defendant's exhibits, having seven cells I think and three emulsifiers and a cleaner and a recleaner?

A. Yes, I was there.

X-Q. 199. What did that produce, an air froth with the bubbles coated or a magma with—or a magma or oil froth with the bubbles coated?

A. In my opinion that was an air froth.

X-Q. 200. You think that was the agitation froth or the air froth of the patent in suit?

A. In my opinion that was the process of the patent in suit and the result of the patent in suit.

X-Q. 201. You know how much oil was used?

A. Yes.

X-Q. 202. What is your recollection of it?

A. 36 pounds to the ton.

X-Q. 203. 36?

A. I think it was 36, wasn't it?

X-Q. 204. 42 pounds is what the evidence shows was used.

A. Yes.

X-Q. 205. That is 2.1 per cent, is it not?

A. Yes.

X-Q. 206. What does the patent in suit recommend? From two one-hundredths to five-tenths, doesn't it?

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A. I think it ~~recognizes~~ recommends that quantity. Of course in the case of that working of the plant upstairs there was a waste of oil on the gangue. The slimes took a great deal of oil. There was also an inert oil there which was probably not attached to anything, just wandering about the surface in an emulsion.

X-Q. 207. But didn't interfere with the process going on, did it?

A. Not altogether. I think it materially impaired the results you would have got if you had used the recommendation of the patent in suit.

X-Q. 208. I think you referred the other day to some experiment that had been performed by a witness in the Hyde case in which experiment the concentrate was purer than the tailing. What experiment was that you referred to?

A. I think that was in connection with Everson patent. I think I did that experiment myself for Dr. Chandler.

X-Q. 209. You were an employe of the Minerals Separation, weren't you?

A. I was.

X-Q. 210. And you are still?

A. I am.

X-Q. 211. Dr. Chandler was their expert witness wasn't he?

A. Yes, he was.

X-Q. 212. Did you ever see a demonstration of any patent fail besides the Everson patent, which you made to fail on that occasion?

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A. I don't think I intentionally made that fail. I had certain instructions from Dr. Chandler and the fact that they did not turn out as the patent stated was not intentional on my part. I don't think that I should be accused of that.

X-Q. 213. I did not intend to put it that way, I apologize, and I will ask you if you ever saw an attempted demonstration of any other patent than this one, fail.

A. I saw one here this afternoon that I did myself.

X-Q. 214. I don't know that you described the battea very clearly in your testimony.

A. A batea is a dish, hollowed out in the center somewhat conical; the instrument may be made of wood or sheet iron; it is not very deep; I suppose the pit of the hollow will be about two and a half or three inches below the edge of the pan or dish.

X-Q. 215. The center is concave to the extent of two or three inches, you say?

A. Yes.

X-Q. 216. How do you describe the float produced as the result of the Froment process; I think you called it a magma or oil froth?

A. Yes, I should call that a magma, distended, of course, by gas bubbles.

X-Q. 217. You are not at all in agreement with the statements contained in the two British patents referred to by Dr. Sadtler, of which Minerals Separation is grantee and in which the Froment process

is referred to as a means of forming mineral-bearing froth. You do not agree with that statement evidently?

MR. WILLIAMS: I think it would be well to present the statement to the witness rather than ask him to agree with things which may not be just as you state them.

MR. SCOTT: I will hand the witness the copies of the testimony and he can look for himself.

X-Q. 218. It occurs several times in the first one I hand you, and if you will hand me your book I will find you the other patent. I think that will do for a sample of what is in this one.

A. The first quotation did not make any difference at all between these froths, and did not say so.

X-Q. 219. I call your attention to the one in patent No. 7803 of 1905. I will ask you if that is not the British patent corresponding to the patent here in suit.

A. Yes, I think that is true. I should not say those are exactly the same nature. It seems to me they were made by different processes and I cannot understand how they could be.

X-Q. 220. MR. WILLIAMS: That refers to patent No. 23820 of 1910.

THE WITNESS: As to No. 10929 of 1910, those froths are not the same in my opinion, but it appears to me to be very feasible that magma could be blown up by the process that is described there. It might be suitable for that apparatus to be used in one of these

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results that are mentioned, but in my opinion they are not the same result.

X-Q. 221. How long have you been an employe of Minerals Separation and its predecessors in interest?

A. Well, in 1903 I was in the employ of Sulman and Picard nominally, but I believe really in the employ of Minerals Separation, though I do not know just what the title was at that time.

X-Q. 222. Are you a stockholder in Minerals Separation?

A. No, I am not.

X-Q. 223. Are you a stockholder in any of the companies allied with Minerals Separation Limited, the American corporation or any of these others?

A. No, I am not, although I hope to be some day.

X-Q. 224. Have you any contract or agreement contingent upon any occurrences that it will be possible for you to become a stockholder?

A. No.

X-Q. 225. Did you, in your testimony the other day, tell us the speed of the revolutions of the machine in which you first tried to demonstrate the process of the patent in suit, and failed?

A. Yes, I think it was about 850. We attempted to keep it at 850, but at first it stuck a little, and I think we remedied that.

X-Q. 226. You mean that the apparatus did not operate—did not rotate as rapidly as it should, and you think that you finally did get it to go at 850?

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A. When we made the test I think it was going at 850, yes.

X-Q. 227. That was the first attempt to demonstrate the patent in suit, made, I think, last Friday?

A. Yes, Friday.

X-Q. 228. At what speed did you rotate the apparatus in your first attempt here today, to demonstrate the application of the process of the patent in suit to the Butte & Superior ore?

A. It was the same speed, as far as we could get it, 850.

X-Q. 229. The speed was taken, was it?

A. Yes, they took the speed with a speedometer.

X-Q. 230. I wish you would ascertain with precision just what speed was taken today.

A. I have not got the exact figure. You see we can not take it when the machine is charged with pulp, but my assistants give the figure at about 900 to 950.

X-Q. 231. That would be the range in the various attempts you made today; that would be the range of speed in all the different intervals of agitation?

A. Yes; it may have gone down to 800 and then up to 950. There was a little variation in speed due to removing the heater off the circuit; that altered the rate considerably.

X-Q. 232. You are now referring exclusively to the first demonstration in which you had four periods of rotation in the attempt to get the froth?

A. Yes.

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X-Q. 233. Then after that, in a different machine, you made another attempt to demonstrate the process of the patent in suit and obtained a froth which I think you said was about an inch and three-quarters thick?

A. Yes.

X-Q. 234. What was the speed of the rotation in that later and more successful demonstration?

A. We set that very carefully for a variation of 850 to 900. I think it went a little over 900; perhaps 950.

X-Q. 235. Can you find out how much?

A. That is as near as I can get it from the information I have.

~~X-Q. 236.~~ The motors are not very satisfactory, or it is the current probably. The power line, probably, the elevator runs on the same circuit, and every time the elevator is used you get a slight variation. I think those limits I have given you are near enough; it could be run a little lower or a little higher without materially altering the results.

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 237. Now, Mr. Higgins, will you observe the froth that you obtained in the experiment you performed first this afternoon and tell me what its present condition is, and what that condition indicates?

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A. It has risen up in the center about half an inch; it looks like dough set down before a fire. That condition could only be due to gas liberated from the ore ~~to~~ settled at the bottom of the vessel.

R-Q. 238. Suppose you met with such a condition as that in the laboratory, what would you do?

A. It would not take very long to destroy that gas; there are several ways of doing it. I recognize that the chief constituent in the case is sulphuretted hydrogen. There is also some smell of phosphi~~tes~~de to me.

R.-Q. 239. What would happen when you got rid of that gas, with that ore?

A. Then it goes very satisfactorily.

R-Q. 240. Now, in this model plant of the defendant which was operated in the grand jury room, do you remember what oil was used?

A. It was a mixture of a heavy petroleum, such as residuum, with kerosene and pine oils. I think the proportions were 70 of the fuel oil or residue, 12 of the kerosene and 18 of the pine.

R-Q. 241. Have you anything to add to what you said as to that operation? You said that that operation carried on the process of the patent in suit?

A. I could also say that it was carried on with, in my opinion, the process of the solution patent.

R-Q. 242. In the portion of your testimony in the Hyde suit describing what you did in a small plant with Elm Orlu ore, I will read on from where Mr.

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Scott read the testimony to you: "Samples were taken of these products and assayed," and then follows the assays, and then: "giving a recovery of 50% of zinc in the concentrates." Now, where was the other 50% of zinc, and in what condition?

A. The remainder of the zinc was in the tailings, as Cattermole granules.

R-Q. 243. If you had wished to carry on the process of concentration so as to improve the recovery, what would have been the next operation?

A. The separation of the granules from the tailings in the manner in which Cattermole describes.

what is the general relation in the specific gravity between the mineral and the gangue?

R-Q. 244. Now in the case of the Black Rock ore.

A. I think zinc sulphide is about four and a half, and the gangue is about one and a half.

R-Q. 245. Were there any difficulties there in regard to separating the mineral in an up-cast or by gravity?

A. Yes; that could not be satisfactorily done without some preliminary process such as sizing.

R-Q. 246. Now, in this operation that Mr. Dosenbach carried on, was the use of an up-cast and the separation in the up-cast a criterion as to the presence of the Cattermole process?

A. No, it was not.

R-Q. 247. You were asked, when you spoke of an Australian plant wherein there were spitzkasten with aprons. I will show you a drawing in the Hyde

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record, marked "Australian Model Plant" appearing on page 1021 thereof. Is that a representation of the plant to which you refer?

A. No, that is not the same plant; that is not the one I was referring to. In the one I referred to with the apron, the apron was much narrower than in this particular plant and extended for a longer distance. It was the plant at work in the Central Mine in Australia.

R-Q. 248. And this drawing showing spitzkasten with aprons gives the general illustration, does it or not, of the apron idea?

A. Yes; the principle is the same.

R-Q. 249. Now, what characteristics has the Janney machine as to agitation which resembles or differs from the prior art agitation?

A. The agitation is very much more violent, and that has the result of making innumerable more bubbles and very much smaller bubbles.

R-Q. 250. What was the amount of oil that streamed into the separating tank in the Kirby experiment that you carried on in court?

A. That was approximately 230 grams.

R-Q. 251. And that was what percentage of the ore?

A. 5.75%.

WITNESS EXCUSED.

MR. WILLIAMS: It is noted that Mr. Chapman was requested to present a screen analysis of the feed

to flotation machines at the Anaconda plant, and he has now produced it, and it is offered to counsel for defendant, and I offer it in evidence, or it may be copied into the record.

MR. SCOTT: Let it be copied into the record.

"SCREEN SIZING TEST ON DORR CLASSIFIER OVERFLOW, OR FEED TO FLOTATION MACHINE.

Screen Size Square Mesh	Aperture, Mm. Square	Cumulative Per Cent. Solids
+ 16	1.180	0.3
+ 2~~5~~4	0.730	1.3
+ 40	0.430	3.0
+ 60	0.260	5.8
+ 80	0.210	12.8
+110	0.130	38.5
+130	0.110	42.3
+160	0.085	54.8
+200	0.076	59.3
+240	0.063	62.8
—240	0.063	37.2"

MR. WILLIAMS: Mr. Chapman was also asked to furnish a flow sheet of the Braden Copper Company plant, including the flotation plant, and this flow sheet is now produced and offered in evidence and marked Plaintiff's Exhibit No. 301.

Flow sheet admitted in evidence marked PLAINTIFF'S EXHIBIT No. 301.

GEORGE A. CHAPMAN, a witness for plaintiff, recalled for cross examination, testified as follows:

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 2. You have indicated the oil feed and the acid feed on this flotation sheet, exhibit 301. I will ask you what kind of oil is used at Braden?

A. A mixture of Swedish wood tar oil, the same as is used for sheep dipping in South America, and American fuel oil.

X-Q. 3. Texas fuel oil?

A. Texas, chiefly.

X-Q. 4. You may have testified to that before, but I was not sure.

A. Yes, it is in the record.

WITNESS EXCUSED.

MR. WILLIAMS: Save for the fact that we have a few assays that are not quite ready, and that I wish to offer in evidence photographic copies of the pages of Ure's Dictionary which were referred to by Mr. Higgins, and that there was some material to be furnished by Mr. Wiggin, who happens not to be in court today, plaintiff's case is closed.

MR. SCOTT: I would like to examine two or three witnesses on sur-rebuttal on points that have arisen in the course of the rebuttal testimony. The first will be Dr. Sadtler.

MR. WILLIAMS: If your honor please, would it not be well for us to know whether or not these are new points that have arisen; because if they are not we will object to them.

THE COURT: We will know better when we hear the questions. I suppose we can assume, and possibly should assume that that is their intention. He says it is sur-rebuttal, and we can not tell until he asks the questions.

MR. WILLIAMS: I thought it might possibly simplify matters if counsel will state what he expects to prove, and then your honor can decide upon it.

THE COURT: You may call your witness.

DR. SAMUEL P. SADTLER, recalled on behalf of defendant in sur-rebuttal testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Have you made any investigation, Dr. Sadtler, regarding the possibility of the kerosene used by Mr. Dosenbach containing a soluble ingredient, and if so, whether such soluble ingredients, if present has any effect?

A. I have carried out examinations—

Q. 2. MR. GARRISON: Your honor, I think we should be entitled to a yes or no answer; so that we can understand the trend of this testimony.

A. I have made investigations of kerosene samples referred to in connection with the testimony here. The one sample which was used, I believe, in an experiment by Mr. Phillips, and I analyzed that kerosene and some other.

Q. 3. Will you please describe the nature of your investigations?

A. I analyzed several samples of kerosene with particular reference to ascertaining as to what amount of foreign matter they contained, and what is soluble. The general outline of the method is as follows: 500 c.c. of kerosene sample are shaken up thoroughly with 500 c.c. of distilled water—shaken up so that the whole mixture was thoroughly broken up into fine bubbles throughout, and thoroughly intermingled, then allowed to settle and separate again in layers. Most of the kerosene layer was then poured off, and then the water was filtered through a wetted filter, a filter which had been wetted, so as to hold back any minute particles of oil. Now, having this watery filtrate, 100 c.c. of this filtrate was shaken up with pure chloroform. The chloroform was specially tested and found to be absolutely free from any impurities and to evaporate without residue and without any odor that was foreign at all to the chloroform. The chloroform was then run into a tared porcelain crucible and evaporated at a gentle heat on a warm plate. Then the odor of the residue, if any, was noticed, and the residue was weighed up. Similarly, 100 c.c. of the

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filtrate was evaporated direct in a small beaker on a warm plate, to note the character of the residue and the odor, if any. I also determined the specific gravity of this watery distillate that was obtained from the shaking up of the kerosene and the filtering, so as to compare it with specific gravity of the distilled water taken at the same temperature and in the same specific gravity bottle, under exactly parallel conditions. I also tested the original kerosene sample with a dilute aqueous solution of methyl orange, as an indicator of free acid. I also tested the original kerosene sample with phenol-phthalein as an indicator of free alkali. This series of tests were applied to a number of kerosene samples. I will give first the results gotten with an average purchased water white kerosene, purchased from a grocery store here in Butte, and which I expected to take as a standard, because of its supposed purity. The chloroform residue—

MR. GARRISON: Your honor, I don't see how this is proper sur-rebuttal in any sense, a matter that this gentleman ascertained from some kerosene that he purchased in Butte. That can not be material in this case.

A. (Continued.) I will leave that be and take up another. I will take next kerosene "A"; that was a sample, as I understand, corresponding to what was used in the court experiment, and a sample of that was taken from a drum on the 16th day of April, 1917 at the same time as that which was drawn and brought and used here in court. The person who took it from

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the drug has given me his data, and he is here in court. The specific gravity of the sample of kerosene "A" which was used, and which was furnished also to the plaintiff at that time, and I believe it is the same sample concerning which Dr. McIlhiney has testified, the same kerosene about which we have testimony here—the specific gravity of that sample was .820. The chloroform residue gotten as described a moment ago from 100 c.c. of this sample corresponding to 100 c.c. of the oil—originally, of course, I took 500 c.c. of the oil and 500 c.c of water. Taking 100 c.c. of filtrate, corresponding to 100 c.c. of the oil, the chloroform residue was .0098 grams, which gave a slight woody odor. Now, 100 c.c. of the oil of .820 specific gravity, would weigh 82 grams. The residue was therefore .012 of 1%, reckoned on the oil. This was the amount of material which has been withdrawn by the distilled water and after-extracted from the distilled water by the chloroform and left on the gradual evaporation of the chloroform.

The residue from 100 c.c. evaporated on the hot plate by direct evaporation was a slight film, but I recognize the same slight woody odor faintly distinct, as it came down too. The film was an unweighable amount. The specific gravity of the water filtrate in this case was found to be exactly that of pure distilled water taken under the same conditions in the same apparatus and at the same temperature. The sample was also found to be free from acid by the test before referred to and free from alkali. I carried out again

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an experiment on kerosene "A" after it had been thoroughly washed. The procedure was as follows: Kerosene "A" which has just been reported upon was first washed with an excess of distilled water by agitation in the square glass jar as shown here in court, and by the use of the agitating blades, using distilled water only. After allowing a sufficient time for separation and the whole mass was made thoroughly milky in this complete agitation in the square jar—after allowing sufficient time for separation I then took of the washed oil, the upper layer, 250 c.c. and I shook that up thoroughly again with 250 c.c. of distilled water in a litre flask, and then filtered through a wetted filter as before. I put this through the same form of analysis or tests as before described. The chloroform residue from 100 c.c. of this water filtered corresponds to 100 c.c. of the oil, therefore was .0006 gms. with no foreign odor, just the faint odor of kerosene oil. And 100 c.c. of the oil—this oil after the double washing, the gravity was taken, was 0.8112—100 c.c. of this oil of that gravity would weigh 81.12 gms. The residue was then therefore .0007%, or in other words, seven ten-thousandths of one per cent reckoned on oil. That residue was undoubtedly a slight trace of the petroleum which could not be kept out of the watery filter, and as the odor indicated at the end of the chloroform operation was what was there and was weighed up. There was no other odor than that of the kerosene, a slight trace of the kerosene odor. The residue on evaporation of 50 c.c. on

a warm plate was practically nothing, no odor whatsoever. The sample was also found of course to be free from acid and free from alkali. Now, a larger quantity, relatively much larger sample of this double washed sample "A" has been obtained by the method of washing with distilled water and then agitated and I will be ready when the apparatus is here to carry out frothing tests with that double washed kerosene.

Q. 4. For the purpose of showing what?

A. For the purpose of showing that this kerosene absolutely free from any foreign material, did not lose its value as a frothing agent.

Q. 5. Then, doctor, did you also as an experiment—

A. Perhaps I better say a word about the frothing of kerosene.

Q. 6. You may proceed.

A. I have had experience in the past with the frothing of kerosene or kerosene supposed to produce a mineral froth, and I do not agree with the unqualified statement that kerosene is not a frothing oil. Some kerosenes that I have tried cannot be made to raise a froth with the flowing ore pulp. Other kerosenes do. In tests and experiments made several years ago, I tested Pennsylvania kerosene, California kerosene, Oklahoma kerosene, and Texas kerosene, and in three cases out of four I was able to produce excellent mineral froths with kerosenes. With

some of them I did not obtain any results. So I am of the opinion that many kerosenes, absolutely free from any foreign mixture—and I should say that one of these California oils that I mentioned, California kerosenes, I made myself in my laboratory direct from the California crude oil by distillation of the kerosene fraction, the treatment of the same with acid and steam stilling to clear it of light vapors, so that I had a standard kerosene fraction made from California petroleum that I could vouch for as being the genuine kerosene fraction of that crude oil. That kerosene is a good frothing agent, gave me excellent mineral froths. These results were gotten in June, 1914. I analyzed other kerosenes by this same method that I have just described for kerosene "A," but they were not samples that have been here in court.

MR. SCOTT: We will have time to do that experiment before five o'clock.

MR. GARRISON: We are going to object to doing this experiment.

THE WITNESS: Mr. Hackwood is the man to do it for me.

MR. GARRISON: The basis of our objection is this, that it is not sur-rebuttal. They did what they choose to do and we made our comments and their witnesses commented upon our comments, and I cannot see under what theory they can do some experiment which of course would be met by counter experiments ad infinitum.

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THE COURT: What is it you are going to offer?

MR. SCOTT: The experiment is intended simply to illustrate what the doctor testified to, namely, that the frothing power of this kerosene is not due to the presence in it of any foreign substance or any soluble substance such as implied at least—not directly stated by the witness who testified for the plaintiff. Now, the doctor has testified to the investigations he has made, to the fact that he has removed the soluble ingredients, the very minute quantities of such ingredients, and the experiment is intended to show that after such treatment, absolutely removing all of these things, the oil acts precisely as we represented it to act in presenting our principal case.

MR. GARRISON: Now, if your honor pleases, they produce an experiment during the course of their case and the witnesses have said what they had to say about it and your honor had the benefit of visual observation of that experiment. Our witnesses then said what they had to say concerning the same. They have now gotten Dr. Sadtler to come back on the stand and say what he had to say as to what our witnesses said.

MR. SHERIDAN: No, it is not quite that.

MR. GARRISON: Permit me to finish, and then you may answer. Now, the doctor proposes that he—at least Mr. Scott now proffers the doing of another experiment with some preparation made by Dr. Sadtler from what they say was the oil that was used

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in the first experiment. It simply is the opening of the door to infinite repetition by each of us of everything that is now in the case. The case now rests upon the testimony of these witnesses, plus what your honor has seen, and I cannot conceive under what theory they are now going to repeat experiments that have already been performed. They have already presented their experiments, which along with Dr. Sadtler's testimony, presents their side of the case. Our testimony then simply presents our side of the case and it seems to me if your honor pleases, there ought to be an end of the meeting of the issues, and that we have reached that end. If we go on in this way there is literally no end.

We will then produce experiments and analyses to disprove what Dr. Sadtler did, and then they will have somebody else come and without question they will do some other experiments, and it does seem to me that this is the place to meet that and to have a perfectly plain understanding that sur-rebuttal certainly does not mean anything more than meeting the new point that was raised, and the only point that we raised respecting that material was that our analysis showed a certain thing, and then this gentleman comes on the stand and says: "I made an analysis and it does not show the same thing." There is the issue that lies before your honor.

MR. SCOTT: This is not a matter of contradicting facts. I don't know that I would say that this

evidence that Dr. Sadtler is about to give contradicts anything whatever that Dr. McIlhiney said, but he is meeting the inference and the direct statement I think of Dr. McIlhiney that the reason that a certain experiment eventuated in a certain manner was because there was something in this oil besides the kerosene which we represented to be showing to the court. Now, Dr. Sadtler has found out that there was a trace—a minute trace of some soluble substance in there, and I propose to show that it makes no difference whether it is there or not, that this kerosene works in the same way; and in view of the character of the criticism offered it seems to me this is an instance where it is within strict propriety to present sur-rebuttal testimony.

THE COURT: They say you can do anything with figures and the court is beginning to wonder if it isn't true of experiments as well.

MR. GARRISON: The statement Mr. Scott has just made, it seems to me, illustrates the impropriety of this evidence. They have produced an experiment. Now, if they concede that in that experiment they utilized something else than a properly refined kerosene, that argues them out of court, they haven't a right to come here certainly and use a material that is not what they represent it to be, and then upon being detected correct the previous position that they took. So, of course, that is out of the question. Now, they came here and used this particualr material. We say that particular material upon analysis pro-

duced the following results—that is the result of the analysis of this material, from which we will argue whatever we think is proper from that. They produce this gentleman and he shows his analysis, from which they will argue whatever they think is proper from that. Now, in what view of the matter are they to repeat the experiment? I cannot see that this has any place in the sur-rebuttal case. If the amount of material that was found in there is arguable in Mr. Scott's behalf, he has got the benefit of that. Now, if it is arguable in our behalf, we have got the benefit of that. And what have we now that permits them to re-do the experiment? That is all they are going to do. If it is a new experiment, of course it has no place here at all.

MR. SCOTT: We have shown the amount of this soluble substance, which we do not admit is not a part of kerosene, kerosene purchased on the market. Dr. Sadtler has investigated its physical properties. He has not stated that it contains anything that is not proper in kerosene. But, having stated that, we wish to repel the unfair implication put forth that plaintiff's witnesses found the soluble substances in there and leaving the stand with a slurring implication that it was by reason of that soluble substance that the demonstration was a success. But he didn't go farther and prove it. He merely left it as a slur, and I think it is proper that we be permitted in sur-rebuttal to show that with the elimination of this minute, almost my-

thical ingredient, the demonstration operates in precisely the same way.

MR. GARRISON: See what that means! We have got to take this and analyze it and we have got to try our experiment with it and we have to come in and do these experiments. If that is sur-rebuttal, then I don't understand what sur-rebuttal is. That means going over and over the original issues in this case as long as your honor can possibly, physically, sit on the bench. They have had the benefit of Dr. Sadtler's analysis. The new matter we brought in was a matter of analysis. We said that in our analysis we found so and so. This was our analysis. We have brought that in here. If it is an old experiment on what ground do they do it? If it is a new experiment Mr. Scott is not ingenious enough to suggest why they should do it.

MR. SCOTT: If your testimony was not intended to create the impression in the mind of the court that it was by reason of some foreign substance that this demontsration was a success, then the testimony is not properly in the case, and if you admit it was not intended for that purpose I move that it be stricken out.

THE COURT: We will see what we can do with this in the morning. It is now five o'clock and we will adjourn until tomorrow morning.

WHEREUPON an adjournment was taken until 10:00 A. M., Tuesday, May 15th, 1917.

Tuesday, May 15, 1917, 10:00 A. M.

THE COURT: In reference to the matter before the court on the objection:

In this case, the plaintiff, the actor comes and introduces its evidence in chief to support its patent, including the patent; and thereupon the defendant introduces its evidence in defense, as to all the defenses that it has incorporated in its answer, and amongst other things, it presented to the court certain experiments as experiments with kerosene, to show what could be done with kerosene oil under certain circumstances. This kerosene, it seems, was of its own oils, and samples were given to the plaintiff at the time the experiments were performed. At that time or at some time during the defendant's case in chief, it developed that this kerosene might be open to question; it developed from the defendant's own evidence that it had been so contained in vessels that there might be room for a claim that it was mixed to some extent—contaminated we might say with other oils. Now, it was open to the defendant, if it wanted to show the court a kerosene experiment, of course, to satisfy the court of the integrity of its experiment, and of all of its experiments; even as the burden rests on the plaintiff to satisfy the court of the integrity of its experiments. The defendant, however, allowed the matter to stand as it was, and closed its case. Then the plaintiff proceeded to introduce rebuttal evidence; that was the first step in the case in which rebuttal evidence appeared, and the actor prepared to meet the case pre-

sented by the defendant. Rebuttal evidence is such evidence as tends to antagonize or refute the facts brought out by the other party. Rebuttal evidence is never merely reasserting evidence which was introduced in chief, and it is not merely going over his case again by cumulative evidence, reaffirming what was in his case in chief; but it is to meet anything new that has appeared in the other party's case that is not a mere contradiction of the first party's case in chief.

Thereupon the plaintiff, in introducing its rebuttal, introduced testimony of witnesses that this kerosene which the defendant had used in making its experiments did contain other oils and was contaminated, did contain pine oil, if the court remembers the testimony correctly, and there the plaintiff stopped. That apparently was as far as plaintiff cared to go, and possibly as far as it would need to go in impeaching the integrity of defendant's experiment, which the defendant was bound to establish, of course, by the preponderance of the evidence. In other words, if the plaintiff showing that this kerosene contained pine oil—if it has shown it, for it is a matter of witnesses and the credibility of witnesses—if the plaintiff's evidence tends sufficiently to show that this kerosene is contaminated and contains pine oil, so that they have brought the question of the experiment merely in equipose, it might be said that the defendant had failed to establish this as an experiment with kerosene, and as the court remembers it, this experiment was offered—the one in question, as an experiment with kerosene, what

could be done with kerosene. There the plaintiff halted. It is a matter of indifference what might be done with admixtures of oils, as far as this evidence is concerned, because that would simply be introducing a new phase of the case and not that for which the experiments were originally offered.

Now, the defendant offers to bring an analysis of his own oils, which may or may not tend to show contamination or admixture of pine oil; but the defendant goes further and says, "Well, if this oil was contaminated and if it contained pine oil, we have taken it and purified it, and now we will do this experiment over again and show the court a real experiment with kerosene." This seems to the court nothing more or less than a mere reassertion of its case in chief. If the defendant wanted to show the court an experiment with kerosene, it was its duty to show it to the court in its case in chief, and it undertook to discharge that duty. There is no element of surprise in the evidence of the plaintiff that the kerosene was contaminated, or tending to show that it was, because the defendant was itself apprised of the condition of its own oils.

I take it the situation is very much the same as though the defendant in a criminal case would say to the court that it would go out and take the gun with which the killing was alleged to have been made, and the cartridges, and demonstrate by experiment that the gun would not carry the distance at which the evidence tended to show that the victim was killed. Then he goes out and performs the experiment and comes back

and testifies to the court that the gun would carry only one-half of the distance at which the man was really killed—certainly very strong evidence in defendant's favor. But it develops upon cross examination of the defendant and his witnesses that there was admixture of cartridges, which would again leave the integrity of the experiment in doubt. Now, the state in rebuttal proceeds to show that the cartridge used in the experiment contained only half of the powder which was in the cartridges with which the killing was done. Certainly it would not be open to the defendant to show in sur-rebuttal, that it would be sur-rebuttal for him to take cartridges really like those in the gun which actually made the killing and again go out and do the experiment over again.

In this particular case before the court it would now involve that we take this oil that is offered by the defendant, that plaintiff take new samples of it, and go out and analyze it again and come back and tell us about it and give the defendant another opportunity to say, "If this new objection arises we will remove that and perform the experiment over again." It is merely in the nature of cumulative evidence and comes at that stage of the proceeding when the court is bound to say that this see-sawing, if it may be so characterized, from one side to the other in the matter of experiments must come to and end in the interests of the administration of justice. The evidence that is now offered by the defendant is merely an offer to perform a new experiment with real kerosene, without saying

that it did not perform it already in chief. If it did, its case is as it should be; if it did not, the offer comes too late. The objection to the experiment will be sustained. At the same time, of course, it is open to the defense or its witnesses to testify that their oil was not contaminated, or at least not contaminated to an extent that renders it other than a real kerosene experiment.

MR. SCOTT: To which the defendant desires an exception noted.

THE COURT: Note an exception.

DR. SAMUEL P. SADTLER, Resumed the stand for further

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 7. I think, Doctor, that yesterday you gave the quantity of soluble material that you found in the kerosenes we were discussing did you not?

A. The kerosene as now produced?

Q. 8. The kerosene that you washed out to get the quantity?

A. Yes.

Q. 9. To what do you consider the soluble material you found in that kerosene to constitute a contaminant?

A. I do not consider that I found any soluble element in the kerosene after the double washing treat-

ment. I have a slight weight which I quoted on the evaporation of the choloroform in the last place of decimals, six ten-thousandths of a gram, but when that evaporation took place there was no foreign odor and there was just the slight kerosene odor. I believe that the slight weight I have there is due to the fact that the chloroform had a small amount of the kerosene which could not be completely separated from the water, and therefore it simply represents the deficiencies of the method, the impossibility of getting the water free from that minute trace of the kerosene with which it had been agitated so long, and I do not recognize that from the result of my analysis and experiments that there was any soluble frothing agent left in that sample.

Q. 10. You mean after it had been washed?

A. After the complete treatment.

Q. 11. Well, from your experience and investigation in flotation phenomena, is it your opinion that the amount of soluble material which you did find in the kerosene would or would not materially affect its properties as a reagent for use in the flotation process?

A. I do not think it could possibly affect it. Taking the analysis of the kerosene A, as it was presented here in court, and before any of this washing or purifying treatment, I had found, as will be recalled from my testimony of yesterday, twelve one-thousandths of one per cent of contamina, and it is entirely possible that a trace of this or a part of this might have been some of the paraffine, in some way, which was there.

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I have reckoned out on a 300 gram charge of ore, the impurity represented by that perecentage of contamination and it would be nine one-thousandths of a gram, or put in percentage and reckoned on the weight of the ore, it would be .003 of 1%. That is the amount represented by that impurity before any treatment.

Q. 12. Three one-thousandths of 1% of the total weight of the kerosene?

A. Reckoned on the weight of the ore.

Q. 13. With a charge of 25% of the kerosene?

A. Yes.

Q. 14. Do you know of any instance in the practice of flotation in which a quantity of oil or oily substance as small as three one-thousandths of one per cent of the ore, plays a part or is utilized?

A. I do not.

MR. GARRISON: I desire to object; I do not understand that this witness is proffered as a metallurgical expert. I understood he was an oil chemist. I do not understand he had been put forward as a metallurgical expert. Of course if he has been I will withdraw the objection.

THE COURT: I do not understand that the witness said he was a metallurgical expert.

THE WITNESS: I do not profess to have any knowledge of the metallurgical side of the business.

MR. SCOTT: He has given considerable study to this matter of flotation in connection with his knowledge as a chemist, and more particularly in connection with his knowledge of oils. A metallurgist would

be less competent to testify upon this point than Dr. Sadtler because a metallurgist would not have the expert knowledge of oils, which is the doctor's principal occupation.

THE COURT: You are asking him as to his particular knowledge of the process of flotation, if he knows any cases where this amount of oil has been used.

MR. SCOTT: I will withdraw the question.

Q. 15. Is it your opinion, doctor, from your investigation of flotation and your knowledge of oils and the custom of oils, that three one-thousands of one per cent of oil relative to the weight of ore could perform any useful function in affecting flotation?

MR. GARRISON: Now, it just seems to me that is a mere indirect way of producing the same result. I have no objection if Mr. Scott will proffer this witness as a metallurgical expert so that our cross examination of him may test his opinion with respect to metallurgical processes. In that event I should be willing to let this question go in, but the witness protects himself.

THE COURT: Yes, I think so; the objection will be sustained. I think you might ask him if he is acquainted with the properties of the oils, and if this small quantity of whatever he found—what effect it would have on the properties of kerosene. I do not think you should ask him to determine a metallurgical problem in the practice of the art until he has shown

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himself competent. He has fairly said he has had no practical experience. The objection is sustained.

MR. SCOTT: May we have an exception?

THE COURT: The exception will be noted.

Q. 16. MR. SCOTT: Doctor, have you made any investigation relative to the solidification in water at various temperatures of the oil mixture or any ingredient thereof, such as was used at the Butte & Superior Mining Company, and more particularly as used by them upon the day that the representatives of Minerals Separation, Limited, made their inspection of the plant?

A. I have examined the oils and made some tests with reference to settling that question. I heard the testimony of Mr. Greninger that the fuel oil used that day immediately coagulated on coming in contact with the water of the flowing pulp at the temperature which existed on that day, and also that the mixture of the fuel oil, Yaryan pine oil and kerosene used for the frothing mixture that day would coagulate in the same way. The materials which I took were the Greybull fuel oil which was stated to me by Mr. Dosenbach to have been the oil used that day. That is a Wyoming paraffine and a paraffine base, as was also stated by Mr. Greninger. Now I examined that sample, that is, a portion of what was used that day, and this fuel oil at the ordinary temperature is too thick to flow from the bottle as it was shown me, and a thin film of it gotten on the side of the beaker glass shows separation of soft paraffine as a solid, small blotches of sep-

arated froth paraffine. That is probably the same substance that was referred to by Dr. McIlhiney. However, both the pine oil and the kerosene which are used in connection with this fuel oil are solvent for paraffine, excellent solvents for paraffine; and the mixture made up in the proportion as it was, as stated by Mr. Dosenbach, and as it was used that day, the mixture was 64.47% of the fuel oil, 24.30% of the Yaryan pine oil and 11.23% of kerosene of .185 specific gravity. Now, I made that mixture myself as an experiment, taking the materials in this proportion as here stated. I made that mixture entirely in the cold, simply by stirring the ingredients together entirely in the cold, and the temperature of the mixture as taken by a thermometer at the time was 18° C., which is relatively low, and I believe was under the temperature existing in the flotation mixture at the time of the visit on Sunday. I made this mixture up, and after having mixed it thoroughly by stirring in the cold, I had a perfect liquid flowing readily at this temperature of 18° C. I examined it under strong magnifying power and allowed it to flow so as to get a thin film. That thin film was a thick, continuous liquid, with no break in the continuity of the film, no separation of soft paraffine or any solid body. Then a small amount of that liquid was put into a bottle containing cold water and was shaken up energetically and the mixture perfectly disintegrated and emulsified. On examination of the appearance after this continuous agitation I could see nothing but the bunched appearance of the emulsified

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oil, part of it in flocks and part of it in the compact frothy mixture on top of the water in a layer. My opinion, therefore, was, that while the fuel oil taken by itself would give some such separation, the mixture as given, the fuel oil in contact with two solvents in a perfect liquid mixture, does not separate the solid material at a temperature of 18° or at the temperature which probably existed there in the mill.

MR. SCOTT: That will be all, doctor.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 17. Doctor, I understood you to say that the specific gravity of that kerosene was .185.

A. No, I didn't say that.

X-Q. 18. Just tell me what the fact is.

A. You mean the original sample?

X-Q. 19. Oh, no, the kerosene used in the mixture.

A. It was given to me as .815.

X-Q. 20. One of the methods of the manufacture of pine oil is that of steam distillation is it not?

A. That is, with reference to what is called the steam grade.

X-Q. 21. Can't you answer that question?

A. That is one method, the steam grade pine oil as distinguished from the other type of pine oil.

X-Q. 22. Do you know whether Yaryan pine oil is steam distilled or not?

A. I do not know from knowledge as to what its

exact treatment is. As to whether it is entirely obtained by steam distillation, or whether it is partly by direct, I do not know.

X-Q. 23. Is pine oil alkaline or acid?

A. If it is obtained by the aid of direct heat, it is probably acid.

X-Q. 24. Do you know?

A. I do not know with reference to any particular sample. I have knowledge that some samples of pine oil are acid.

X-Q. 25. Were you present at the Butte & Superior plant on the inspection of it made by the plaintiff's representatives?

A. I did not go out.

X-Q. 26. In your examination of the kerosene which corresponded to what was used in the two court experiments, you call that specimen A, don't you?

A. Kerosene A, it is called.

X-Q. 27. How large a quantity of kerosene did you submit to this operation?

A. I took 500 c.c., half a litre for the washing treatment that I applied myself. In this sample which is here now, it had had a previous washing, in which probably more than a litre of it was taken for the first washing by agitating in the square glass jar by the aid of the rotating agitation method. And of that I took a portion after the layer had separated. My experiments were made, as I stated, I believe, by taking 500 c.c. of the oil and the same volume of pure distilled water and slightly agitating until I had the whole

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thing broken into fine bubbles, and then I allowed it to settle again.

X-Q. 28. When did you do this?

A. Last Saturday afternoon, and last Sunday afternoon.

X-Q. 29. And where?

A At the oil laboratory of the Butte & Superior mill.

X-Q. 30. And who gave you this kerosene that you washed?

A. It was furnished to me by the oil chemist there, who had identified it, and I stated that the young man who drew it from the drum, both for the amount produced here in court and for the amount which I took, was present and could testify to that.

X-Q. 31. You did not give me his name?

A. Oh, I beg your pardon, Mr. Dudgeon.

X-Q. 32. And of course you don't know as a fact where he got it?

A. I took it on his statement.

X-Q. 33. Now, in your test of this kerosene "A", the foreign material which you collected was the foreign material which was dissolved out of the kerosene by the water and in agitation, and out of the water, as I understand it, you evaporated it and got some residue?

A. That was one test, direct evaporation. The most important test, the one which yielded a quantitative test, was taking an aliquot quantity of the wa-

ter and extracting it in a separate test with the use of pure choloroform.

X-Q. 34. In that you got such part of this foreign material as possibly was dissolved by the water out of the kerosene, and then as was dissolved out of the water by the chloroform?

A. That is correct.

X-Q. 35. And your final determination was of what was left in the chloroform after you had evaporated the chloroform?

A. The chloroform was driven off by allowing it to slowly evaporate on a warm plate, and carefully noted as it got down for any foreign odor, and then weighed up anything that was left after the evaporation of the chloroform.

X-Q. 36. Having made these two cleanings, did you make another cleaning to make sure that there was no foreign material?

A. Well, I did find what I said was something, probably a foreign material, a trace.

X-Q. 37. In the second cleaning?

A. In that chloroform extraction I did find such.

X-Q. 38. In the second cleaning you did find something?

A. In the second cleaning I found .0006 of a gram, which is practically almost within the limits of the accuracy of the balance, and therefore does not mean anything very much, and the only odor was a slight kerosene odor, and I am entirely satisfied that it is perfectly legitimate to assume that a trace of kerosene was

in that water which was shaken with the chloroform, and of course it would be taken out with the chloroform.

RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 39. Doctor, I would like to ask you what, in your opinion, would be the effect on the properties of kerosene as a frothing agent, of the presence of an amount of soluble matter which you have testified you found in the kerosene?

MR. GARRISON: I object, your honor, unless the doctor is qualified as an expert on frothing agents.

MR. SCOTT: Dr. Sadtler has testified to his extensive investigations, extending over several years of these frothing agents.

THE COURT: I think the doctor has testified to that, stating that there was nothing in there that could possibly affect the kerosene in its frothing effect; that this soluble matter that he found was not enough to possibly—that is the way he put it—effect the kerosene in its frothing effect.

MR. GARRISON: I don't object to the witness testifying to it, your honor understands, but I don't want him to testify to it with the qualification that he is not competent to testify on that subject. If he will commit himself as an expert on frothing agents, I am perfectly willing, but if on cross examination he said that he never pretended to know about these things,

we have all the disadvantage of his testimony and none of the advantage of cross examination.

THE COURT: I suppose there is a distinction between the things which will make a froth and the things which will make a mineral froth.

MR. GARRISON: Your honor catches my point exactly. I don't want to keep it out, but I want to— I want it to come in with some probative force, so that cross examination may develop something. If it should develop on cross examination that he did not claim to be qualified on frothing agents, that would show that his testimony should not have been admitted in the first place. If he will say or Mr. Scott will say that he is qualified as to mineral frothing agents, I have no objection.

THE COURT: I think the doctor testified to that. I think he qualified about frothing agents. Didn't you, doctor?

THE WITNESS: I do not testify as to metallurgical results, but I have had a large experience with froth production and the raising of froth in the presence of mineral; but I stop at the point where the metallurgical effects come in.

THE COURT: Well, it would not have any value except as to the metallurgical results. The metallurgical results are those which are important, not the fact that it might raise some patricle; the objection is sustained.

MR. SCOTT: The other witnesses have testified of the frothing properties of these oils independently

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of the utilization of them in metallurgical processes, and experiments were performed in court that exhibited the frothing qualities of oil aside from the presence of solid matter at all, and the question as framed calls for the doctor's opinion upon the effect of this small, infinitesmal amount of soluble matter, unidentified, upon the properties of kerosene as a frothing agent.

MR. GARRISON: Has the matter been reopened for argument?

THE COURT: You may answer him if you desire.

MR. GARRISON: I have nothing further to say, except that it does seem to me that we are entitled to have the witness come down on one side of the fence or the other. We are perfectly willing, as long as he says he is qualified to give his opinion, but unless he does, the testimony is improper.

THE COURT: It becomes a conjecture then. The ruling of the court will stand.

Defendant excepted.

(WITNESS EXCUSED).

FRANK G. JANNEY, Recalled in behalf of defendant in sur-rebuttal, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. Mr. Janney, you testified before to several years' experience in flotation operations; how many years was it you stated?

A. Since 1912.

Q. 2. And your present position you said was what?

A. General superintendent of mills for the Utah Copper Company.

Q. 3. Now, in the course of your employment, to what extent have you investigated the flotation phenomena?

A. From 1912 to 1914, I spent the greater part of my time personally; since that time I have had engineers investigating the processes but I have not been actively engaged in it myself, except—

Q. 4. At how many different plants have you made investigations of flotation; how many different mines and mills, I mean?

A. Butte & Superior, Ray Consolidated Copper, Chino, Nevada Consolidated, and our own operations at Utah.

Q. 5. Have your investigations caused you to look into the quantities of oil which are necessary or effective or possible in practical use?

A. They have.

Frank G. Janney.

Q. 6. What would be your opinion as to the use of .003 of one per cent of an oil relative to the weight of ore as to having any effect one way or the other upon the flotation operation?

MR. GARRISON: I object to that, if your honor please. There is no identification here of what it is, this so-called thing that is being inquired about. Unless this witness is prepared to say that he is a prophet of the art and knows all about everything that will be discovered in the future, his evidence is of no value. If they identify anything or ask him within the things that he has examined I have no objection.

Q. 7. To save argument we will limit it to the oils that you have had experience with?

A. In all my experience I have never found an oil or a reagent that could be used in that small quantity and be effective.

Q. 8. Have you become acquainted with the properties of any considerable number of oils or not?

A. I have; in our laboratories I think we have examined about 1200 different oils and fractions of oils.

Q. 9. For what purpose?

A. Determining the properties of the oil, their floating value and the grade of concentrate and recoveries made by the oils.

Q. 10. And it is upon the knowledge so gained, is it, that you have based your answer regarding the use of .003 of one per cent?

A. It is.

Q. 11. Were you present at the mill at the Magna

plant of the Utah Copper Company ~~when~~ upon the day when the mill was visited by the representatives of the Minerals Separation, Limited?

A. I was.

Q. 12. Were you present throughout the period of their visit?

A. I was.

Q. 13. What was your purpose in being there?

A. To assist in the securing of samples which the Minerals Separation representatives wanted, and to obtain a duplicate set of samples.

Q. 14. During the day did you or did you not observe the operation of the plant, aside from getting the samples?

A. I did.

Q. 15. What was your observation in regard to what was taking place in the first cell, I mean the first agitator of your spitz boxes.

MR. GARRISON: I object to this, it is not rebuttal. They did this test run or experiment, whatever they choose to call it, and they have produced or did not produce all the evidence they desired with respect to what they were doing and what the result was, and we gave our testimony as to what we observed and what the results were, and there the matter must rest it seems to me.

MR. SCOTT: Our witnesses testified to the operation of this plant with the quantity of oil then being used, over one per cent, and they testified to the proportion of the froth of the ordinary type with that

Frank G. Janney.

amount of oil, and then the plaintiff in rebuttal produced witnesses who denied that there was a froth on this first cell, as I remember it, they stating that it was an oil magma, or some word that they used. They stated or implied that the oil was being drawn off from the system without accomplishing any purpose. They flatly denied the testimony of our witnesses, and it seems to me that this testimony comes within the most strict definition of defendan's sur-rebuttal testimony.

MR. GARRISON: The very statement of Mr. Scott excludes it. He says their witnesses stated it, and our witnesses denied it, and now he wants to reaffirm it.

MR. SCOTT: Our testimony was directed to the plant as a whole, and this one unit was picked out by these witnesses for Minerals Separation, and it was about that that they stated that this one unit was operating differently from the rest of the plant, drawing a distinction between these things which no man ever could have anticipated would have occurred to anyone. Our witnesses having examined the thing and found it to overflow in their examination, they are not responsible and we are not responsible for not recognizing a hair-splitting distinction between the individual cells, and we think we are entitled to rebut that.

THE COURT: This was a test with a large amount of oil?

MR. SCOTT: No, the plant was running in its normal operations with something like 21 or 22 or 23 pounds of oil.

Frank G. Janney.

THE COURT: The defendant introduced testimony showing that they performed such a test run. The plaintiff then comes in and says that may be true, but that at a certain point there was a defect in the test. Now, it is quite a different case than the offer in respect to the kerosene oil. The kerosene test was offered as a kerosene test pure and simple, and when the plaintiff showed that it was not a kerosene test and there halted, the defendant should not be allowed to bring it in again. I think this is different, I think the defendant should be allowed to show that that first cell performed its normal function. I think this is fair rebuttal. The objection will be overruled.

Plaintiff excepted.

Q. 16. MR. SCOTT: The question, Mr. Janney, was to ask you to describe the operation of the first cell.

A. The first cell was operating as an emulsifier and had been operating as an emulsifier for some time as a matter of fact I think it was operating as an emulsifier since the middle of January. No concentrate was produced on that cell. As a matter of fact the gates between the first and second cells were left open, and there is no adjustment made on that cell. It is not the intention in our operations to produce a concentrate on that cell, and although a concentrate is formed of mineral bearing froth, it is not discharged. Occasionally the froth fills up to such an extent that it discharges of its own accord, but not with our intentional operations.

Frank G. Janney.

Q. 17. You might explain just what you mean by emulsifier and the relation of the emulsifier to the flotation plant proper, or the overflow of concentrate that takes place?

A. In the design of our flotation plant we use two cells for preliminary beating of the pulp before it enters the spitzkasten.

Q. 18. What is that preliminary beating for?

A. For emulsifying and distributing the oil equally throughout the pulp.

Q. 19. And those two emulsifiers are simply mixing boxes without preparation for overflow or collection of froth?

A. They are.

Q. 20. In what respect did this first cell differ from the emulsifiers that are especially provided for use as emulsifiers?

A. The function was exactly the same as the emulsifier. The same agitation; the same speed of motor, except as to the spitzkasten which was simply acting as a receiving box through which the pulp was circulating.

Q. 21. And what effect upon the overflow from the spitzkasten did the fact that the gate was open to the second cell have?

A. The water level in the first spitz was at the same height as it was in the second spitz.

Q. 22. But the second spitz as I understand is built at a lower level than the first?

A. Six inches.

Frank G. Janney.

Q. 23. And by having the water level in the first cell at the same height as that in the second, what effect was there upon the overflow of froth from the first cell?

A. Well, the froth would have to build up about six inches deep before it could discharge. As a matter of fact it would have to build up to about eight inches because the water level of the cells which are discharging concentrate is about an inch to two inches below the spitz overflow.

Q. 24. What is the character of this float that builds up in the first box of the first cell in the unit we are now discussing?

A. It is a very light aerated froth, and the fact that it lies dormant on the surface of the water, and any air that is released in the spitzkasten has to rise through that froth, the result is that we get a very light, large bubble, aerated froth.

Q. 25. Now, will you just describe the course of the pulp as it goes into the first emulsifier and proceeds down to the second cell?

A. Well, the feed is drawn from the sludge tank and flows by a launder into the bottom of the first emulsifier. This emulsifier contains a ten horse power motor, and attached to the rotary are two impellers. The motor runs at 570 r. p. m. It flows into the bottom of the emulsifier and is elevated by the impellers and discharged over the top, and from there it flows into the bottom of the second emulsifier and is elevated by the impellers and discharges from the top.

Frank G. Janney.

From the second emulsifier it flows into the bottom of the first cell. It is elevated—

Q. 26. Where it flows into the first cell, what part of the first cell does it flow into?

A. It flows directly into the mixing chamber.

Q. 27. Is that mixing chamber of the first cell any different from that of the two emulsifiers that precede it?

A. It is not.

Q. 28. After it goes into the mixing chamber of the first cell where does it proceed?

A. It is elevated by the impellers and discharged into the spitzkasten.

Q. 29. And after the pulp gets into the spitzkasten what becomes of it?

A. A portion of it is returned to the cell and a portion of it goes into the second cell through a gate between the spitzkasten.

Q. 30. The same gate you referred to before?

A. The same gate.

Q. 31. And eventually all of the pulp gets into the second cell does it?

A. It does.

Q. 32. But part of it circulates around the cell before it proceeds to the second?

A. It does.

MR. SCOTT: That is all.

Frank G. Janney.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 33. In this blue print which is attached to and forms part of exhibit 251, the flow sheet of the plant, is it a flow sheet as it was operated on April 21st, 1917?

A. It is.

X-Q. 34. I notice the sampling legend has as its last item "First spitzkasten overflow." That is true is it not?

A. It is.

X-Q. 35. And when we turn to the assays, I find, "Machine No. 1, Spitz No. 1 overflow" that being the product which had 412 pounds of oil per ton of mixture—per ton of mixed concentrate and oil? That is right is it not?

A. Yes.

X-Q. 36. Now, I understood you to say that this was not an overflow at all. Is that right?

A. It was not. That sample was taken from the froth floating on the No. 1 spitz and it was called —I marked it "First spitzkasten overflow" from the fact that your representatives marked it that. My samples were marked exactly the same as your asmples so that there would be no question or dispute as to the identity of the samples.

X-Q. 37. Now, Mr. Conrads was the flotation superintendent of that plant, wasn't he?

A. He was the metallurgical engineer.

Frank G. Janney.

X-Q. 38. Mr. Conrads came here and testified that that plant was operated with double spitzkastens discharging the concentrates. Do you contradict him?

A. It was a portion of the time, and as I said, to about the middle of January, that concentrate was discharged from that cell.

X-Q. 39. And when Mr. Conrads came here and testified as to operating through February and March he must have—

THE COURT: Well, well, I think it will be for the court to pass on that.

MR. WILLIAMS: I wanted to get the attitude of the witness in the matter.

THE COURT: If his testimony is in conflict with Mr. Conrads' testimony it will be for the court to determine. Of course you may point it out to him, and ask him to explain if he can, but to ask him to pass upon the credibility of another witness—

MR. WILLIAMS: I will withdraw the question.

X-Q. 40. Is there anything in this flow sheet that was furnished us to show or indicate that the first cell was used as an emulsifier?

A. Nothing.

X-Q. 41. In your extensive study of flotation which has extended over a good many years have you ever used the Australian eucalyptus?

A. I have.

X-Q. 42. In how small quantities have you used that?

Frank G. Janney.

A. I can't say definitely. I can't say.

X-Q. 43. Do you think you have ever used it in as small quantities as half a pound eucalyptus oil to the ton of ore?

A. No, I have not.

X-Q. 44. Have you used pure phenol?

A. I have.

X-Q. 45. In how small quantities have you used pure phenol?

A. I can't say without looking up my tests.

X-Q. 46. As a matter of fact it would be quite a feat of memory for you to give these proportions?

A. It would.

X-Q. 47. And you have used pure cresol have you?

A. I have.

X-Q. 48. And can you tell me in how small a quantity you have used that?

A. I can not.

X-Q. 49. Now, you mentioned a large number of mills at which—I am not quite sure I got your testimony—you tried flotation. Was that it?

A. Investigated it.

X-Q. 50. Investigated it?

A. Yes, sir.

X-Q. 51. And I take it your investigations were for the purpose of assisting the operations or directing the operations?

A. They were.

X-Q. 52. Those companies are known as the Jackling group, are they not?

Frank G. Janney.

MR. SCOTT: I object to this question. I don't see that it is a competent, material or relevant question to anything connected with this suit.

MR. GARRISON: Here we have a rather remarkable situation of interchange of employees, of superintendents in one mill going to another mill to assist, and all of them coming here to oppose us, and I think we have a perfect right to show the interest of these various people in each other's business. It tends to weighing the credibility of the witnesses.

MR. SCOTT: No interest is shown by the question in the form as put.

THE COURT: No, it is only a single question. I think he may answer. Objection will be overruled. Read the question.

(Question read as follows: Those companies are known as the Jackling group, are they not?)

A. They are.

X-Q. 53. MR. WILLIAMS: Now, as to the Navada Consolidated, how long ago was it that you were assisting them in their operations?

A. I think it was in 1914, I am not positive.

X-Q. 54. You testified about that in the Miami trial to a slight extent?

A. Yes.

X-Q. 55. What oil proportions were they using at the time that you assisted them?

A. Well, they varied.

X-Q. 56. Well, within what general limits?

A. About 2½ to three pounds.

Frank G. Janney.

X-Q. 57. And they were agitating in a Janney machine?

A. They were.

X-Q. 58. And producing a froth which carried the metalliferous mineral?

A. They were.

X-Q. 59. And these figures you gave of course were in pounds of oil per ton?

A. Yes.

X-Q. 60. How do you adjust the overflow of the type of Janney machine that was at the Utah Magna plant when it was exhibited to these representatives?

A. Through a gate which acts as a valve, in a partition between the cells. As you close the aperture you raise the height of the water in the spitzkasten.

X-Q. 61. Mr. Wicks testified to a Janney machine wherein there was a standpipe regulation of the flow level in the spitzkasten. These machines were not of that type?

A. They were not.

X-Q. 62. It was just a matter of regulating the level by controlling the overflow?

A. Absolutely.

X-Q. 63. And I take it that that method of regulating the level is apt to be varied by an increase of feed, is it not? That is to say, if the feed increases the level will go up? Isn't that true?

A. Why, yes.

Frank G. Janney.

X-Q. 64. And, on the other hand if the feed diminishes, the level will go down?

A. It will.

X-Q. 65. That is to say as compared with a standpipe overflow you haven't got anything that controls the overflow at a fixed level? Is that right?

A. That is right. That is what we have the sludge tanks for. That is to say the purpose of the sludge tank is to take up an increase of feed and carry it and so regulate to some extent the feed to the flotation machine. That is the purpose of it.

X-Q. 66. You didn't tell me what oils they used at the Nevada Consolidated at the time that you assisted them?

A. I don't remember now; we were experimenting. We used a good many oils.

X-Q. 67. They were flotation oils, of course?

A. Flotation oils, both mineral and creosote as well as wood oil.

X-Q. 68. And of course you know that creosote and wood oils contain soluble frothing agents?

A. A portion, yes.

WITNESS EXCUSED.

EDWARD W. ENGLEMANN, recalled for further

DIRECT EXAMINATION.

BY MR. SCOTT:

Q. 1. Mr. Englemann, when you were on the stand before, you referred to your experience in flotation but I don't remember whether you stated how many years you had been engaged in operating flotation plants or investigating flotation. How long have you been?

A. Since 1913, the latter part of 1913.

Q. 2. And, generally speaking, what has been the nature of your experience since that time?

A. Well, in testing different oils on our products, determining the best mixture that would give the most efficient results.

Q. 3. Have you been employed in more than one flotation mill since you started on the subject?

A. Well, I did testing at the Utah Copper mill, did some testing at the Butte & Superior mill, and some testing work down at the Ray Consolidated.

Q. 4. Can you state in a general way, something as to how many oils you have probably investigated —you have investigated?

A. Well, upwards of 200.

Q. 5. And what was the nature of your investigation of these oils?

A. To determine the best mixture for the most efficient results and to determine the minimum amount

Edward W. Englemann.

of oil that would be consumed in obtaining these results.

Q. 6. In your experience in flotation have you ever used or found it possible to use an amount of oil as small as three one-thousandths of one per cent relative to the weight of the ore?

A. I have not been able to use that small amount of oil and obtain any results.

Q. 7. What is the smallest amount you ever were able to use?

A. About—Oh, .025%, or about half a pound, I think, is about the smallest I can ever remember of using efficiently.

Q. 8. Half a pound per ton of ore?

A. Yes, sir.

MR. SCOTT: You may cross examine.

CROSS EXAMINATION.

BY MR. WILLIAMS:

X-Q. 9. What frothing agent did you use in that small percentage, half a pound to the ton?

A. I used a mixture of—if I remember right, one mixture was of Barrett's No. 4, creosote and crude oil, and I used a mixture which we first started, I think, in the testing machine, about half of crude and half of pine.

X-Q. 10. Didn't you ever try pine oil alone?

A. Yes.

Edward W. Englemann.

X-Q. 11. Didn't you get even a little smaller amount when you used the pine oil alone?

A. Well, in the use of pine oil alone I have not been able to maintain any kind of a result with our ores. When I used the pine oil the bubbles were so delicate they would not carry the mineral.

X-Q. 12. So upon your ores you have not found that pine oil alone is a suitable oil?

A. We have not.

X-Q. 13. Now, what sort of a result did you get when you were using that mixture, about half a pound of creosote, was it?

A. Creosote and crude.

X-Q. 14. Creosote and crude?

A. Well, that was in our slime treatment. I have not been able to use as small as half a pound on our retreatment plant product, that is, heavy mineral, but our product averages about 75/100ths of copper; we maintained tailings that would run about .43 of 1% copper.

X-Q. 15. Was that good work?

A. Well, it wasn't as good work as we have done with .75 of one pound. Our average consumption will go about three-quarters of one pound.

X-Q. 16. That creosote contained a soluble frothing agent, didn't it?

A. Well, I suppose it does. It is regular coal tar creosote.

X-Q. 17. Aren't you doing some work at your

Edward W. Englemann.

plant in the way of floating freshly precipitated copper?

MR. SCOTT: I object to that as absolutely incompetent, irrelevant and immaterial and having no bearing upon any issues in the case, but a mere inquiry into confidential matters and processes other than those concerned in this suit.

MR. WILLIAMS: I submit that he has testified as to his experience at his plant, and I am going to find out about some of them. Of course I am not going to press it into anything that will—

MR. SCOTT: I insist upon the objection. The question is an absolute bold attempt to pry into confidential affairs and has no relation to this suit, none that is possible of explanation.

THE COURT: I can not say that. I will have to trust to counsel. Even if it is confidential, if it came down to the point of the quantity of oil or something that would show the experience of this witness it can not be helped. Counsel at the same time says he is not seeking that. I think we will have to trust to his statements. It is cross examination. The objection is overruled.

MR. WILLIAMS: In view of the objection of counsel I will say that I am not seeking any information that will be of the slightest value to my clients, But I am seeking knowledge that has a bearing upon the point in issue.

X-Q. 18. (Question read as follows: "Aren't you

doing some work at your plant in the way of floating freshly precipitated copper?")

A. We have done some experiments.

X-Q. 19. MR. WILLIAMS: Well, now, in this work, in what form have you produced the float of the freshly precipitated copper? In the form of a froth?

A. Yes, sir.

X-Q. 20. I propose to ask you just the essential question. I haven't any desire for anything else than what I determine essential and if you will just answer me directly I guess we won't get into any confidential disclosures. Now, for the production of that floating mineral froth, what frothing agent did you use?

A. The same frothing agent that we used in the regular operations.

X-Q. 21. And in what proportions?

A. 75% Barrett's No. 4 and 25% of fuel oil.

X-Q. 22. Now that is the relative proportion of one oil to the other.

A. Yes, sir.

X-Q. 23. Now, what was the proportion of this total oil mixture per ton of material treated?

A. You mean in the testing that we are doing?

X-Q. 24. Of course you make your computations on the basis of that?

A. Well, I don't quite get you.

X-Q. 25. Just give me the figures on the basis of tonnage of dry material treated.

Edward W. Englemann.

A. Are you figuring on the testing work we are doing or the actual operations in the plant? Are we speaking now of the—

X-Q. 26. I am speaking now of the testing work that you are doing.

A. Why, in these tests we average about a pound and a half of oil per ton.

X-Q. 27. And is that true of all the tests?

A. No, that is just true of this soluble copper testing that you are speaking of.

~~X-Q. 28. But it is true of all the soluble copper testing that you are speaking of.~~

X-Q. 28. But it is true of all the soluble copper tests is it?

A. Well, it will average that. We really are not trying to determine the amount of oil we will have to use on this, it is a question of getting the soluble copper. That is the object of the tests.

MR. WILLIAMS: That is all.

WITNESS EXCUSED.

JAMES WALTER DUGEON, a witness called in sur-rebuttal after being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Dudgeon, will you please state your full name?

A. James Walter Dudgeon.

Q. 2. And your residence?

A. 939 West Granite, Butte.

Q. 3. You are employed at the Butte & Superior Mining Company?

A. I am.

Q. 4. In what capacity?

A. I am experimental man in the flotation laboratory.

Q. 5. What do you know about the source of the kerosene "A" that was given to Dr. Sadtler for analysis, as testified to by him this morning?

A. The sample of kerosene "A" which was given to Dr. Sadtler for analysis was drawn from the container along with the samples which we used here in court, and on the same day.

Q. 6. You have personal knowledge of that fact?

A. I drew the kerosene myself and marked the bottles.

MR. SCOTT: That is all.

James Walter Dudgeon.

CROSS EXAMINATION,

BY MR. GARRISON:

X-Q. 7. What was this container?

A. It was a steel drum.

X-Q. 8. Was it the original package that came from the person from whom you purchased it?

A. I have no knowledge of that. It was the container from which I was told to draw the kerosene.

X-Q. 9. What I am trying to find out is it the thing that the kerosene came in, or is it something in which the kerosene was put after it gets to your plant?

A. It is the tank which we have at the plant, and which we used to keep the kerosene in.

X-Q. 10. And you drew it off into what, do you say?

A. Into two litre glass bottles.

X-Q. 11. And when did you draw it?

A. It was on the 16th of April as near as I can remember of this year—the samples that were used.

X-Q. 12. And what samples do you refer to that were used?

A. Just the quantity of kerosene that we drew for this case, to use in experiments about the laboratory.

X-Q. 13. And you kept that up there at the mill, around the laboratory?

A. Yes, they were kept there, marked.

X-Q. 14. And these bottles that you drew, you found in the laboratory on the day that you gave these samples to Dr. Sadtler, is that correct?

A. Just a minute, until I understand the question.

James Walter Dugeon.

X-Q. 15. (Question read as follows: "And these bottles that you drew, you found in the laboratory on the day that you gave these samples to Dr. Sadtler, is that correct?")

A. This bottle, or this sample of kerosene about which Dr. Sadtler testified was one which I had put away as the duplicate samples of the ones we were using in court.

X-Q. 16. What I want to know is actually did you draw off two bottles?

A. No, there were four or five I don't remember just exactly how many.

X-Q. 17. However many there were, let's say five for an arbitrary number. What did you do with those five bottles after they were drawn off, the physical bottles, what did you do with them?

A. I took them to the laboratory.

X-Q. 18. What laboratory?

A. Our flotation experimental laboratory.

X-Q. 19. Where is that?

A. At the Black Rock plant of the Butte & Superior Mining Company.

X-Q. 20. And some kerosene from one of these bottles that we have assumed were five,—was that what was given to Dr. Sadtler?

A. Yes, sir.

X-Q. 21. And some of this same kerosene you testified was the kerosene that Dr. Phillips used? Is that correct?

A. I have no knowledge of what Dr. Phillips used,

as I was not personally present when he made his experiments.

MR. GARRISON: That is all. Now, if your honor pleases, I ask to have stricken out all of the testimony of Dr. Sadtler respecting the analyses that he made of the kerosene. The only way in which he identified it as the kerosene used by Mr. Phillips was by referring to Mr. Dudgeon. Mr. Dudgeon now says he has no knowledge as to what kerosene Mr. Phillips used. Therefore the testimony of Dr. Sadtler is left without any basis whatever to stand on.

MR. SCOTT: We will call another witness on that.

THE COURT: On the promise of counsel, the motion will be denied.

ARTHUR WELLSLEY HACKWOOD, a witness called in sur-rebuttal, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. State your full name.

A. Arthur Wellsley Hackwood.

Q. 2. You are employed by the Butte & Superior Mining Company?

A. Yes, sir.

Q. 3. In what capacity?

A. I am in charge of the flotation laboratory directly under Mr. Dosenbach.

Arthur Wellsley Hackwood

Q. 4. And you live in Butte, Montana?

A. Butte, Montana.

Q. 5. Will you state what you know about the kerosene A, which was used by Mr. Phillips in demonstrations made in this court?

A. It was on the 16th of April when we were preparing material to bring to the court, from the laboratory, I asked Mr. Dudgeon to get a number of samples of kerosene from a tank, steel drum that we have there, that this kerosene is stored in. I asked him to bring a number of bottles to the laboratory. I stood in the door and watched Mr. Dudgeon—I could see him right out of the laboratory, and saw Mr. Dudgeon get the samples right out of the barrel into these bottles, and we brought them up and took one of these bottles for a duplicate sample to keep for use as we do with all oils taken at the plant, that is, whether carload shipments, small samples—no matter what they are, we keep a sample for reference in the laboratory at all times. And one of these bottles was put away there with the rest of them marked properly and the date it was taken. This was a sample and a representative sample of the same oil that I gave to Dr. Phillips to use for his experiment.

Q. 6. You mean that you gave Dr. Phillips one of these several bottles?

A. Yes.

Q. 7. And you saw all the bottles drawn out, you say?

A. I saw all the bottles drawn out.

Arthur Wellsley Hackwood

CROSS EXAMINATION

BY MR. GARRISON:

X-Q. 8. When were these bottles filled?

A. I think it was on the 16th of April.

X-Q. 9. And when were Dr. Phillips' photographs made?

A. I don't know.

X-Q. 10. You don't know with what he made the photographs then, do you?

A. I saw him run the experiments upstairs with the kerosene; I don't know the date; I don't remember the date.

X-Q. 11. How long after you had had these bottles filled was it that Dr. Phillips made the experiment that you saw him make that you have just spoken of?

A. I don't remember the date.

X-Q. 12. I didn't ask you the date. I asked you how long ago was it. Was it an hour or ten hours, or was it a week?

A. I don't know that; I don't know the length of time.

X-Q. 13. Can't you give us any guess at all?

A. No. It was some time during the trial, since April 16th to the time he made the demonstration in court is all I know.

X-Q. 14. And that is the best means you have of describing that date, is it?

A. On the date that he did it, yes, sir.

Arthur Wellsley Hackwood

X-Q. 15. And where were these experiments made, the part you say you saw?

A. Upstairs in the laboratory we have fitted up; upstairs in the jury room.

X-Q. 16. And the kerosene that he used upon that occasion, where did you see him get that? Where did he get that from?

A. I handed him the bottle myself.

X-Q. 17. You haven't answered my question yet. Where? Where, I said? Where?

A. Out of—

MR. SHERIDAN: Let the witness answer the question.

MR. GARRISON: Yes; let the witness answer the question. Where?

X-Q. 18. (Question read as follows: "And the kerosene that he used upon that occasion, where did you see him get that? Where did he get that from?)

THE COURT: Now the witness has answered it hasn't he?

X-Q. 19. MR. GARRISON: All I want to know is where?

A. Out of one of the bottles that I gave him.

X-Q. 20. Well where, sir; where were you? In what locality? What place?

A. Upstairs in the jury room.

X-Q. 21. And where had that bottle been in the meantime?

A. In the room all the time; upstairs in the room.

Arthur Wellsley Hackwood

X-Q. 22. And the sample that was given to us, where did that come from?

A. Out of one of those bottles; probably the same bottle.

X-Q. 23. You are not sure?

A. No, I am not sure. It was out of one of the representative bottles, anyhow that contained it.

X-Q. 24. What was the size of this bottle?

A. A two-litre bottle.

X-Q. 25. Well, give it to me in ounces. I know a little bit about ounces but I don't know a thing about litres. How much would two litres be in ounces?

A. I think there is about 29 c.c. to an ounce; somewhere around that.

X-Q. 26. Well, figure it out for me; I am not doing this for amusement. I really don't know. When I go into a drug store I ask for four ounces or six ounces or eight ounces. I do not speak in terms of litres. Can you give it in pints or quarts or gallons?

A. Probably about two quarts. If someone will give me the exact number of cubic centimeters to an ounce I will figure it out.

X-Q. 27. There's a bottle sitting on that experiment table. Is that a two litre bottle?

A. That is a 2500 c.c bottle.

X-Q. 28. Well, is that a two litre bottle?

A. No.

X-Q. 29. What is it?

A. It is a two and a half litre bottle.

X-Q. 30. Then a two litre bottle would be a little smaller than that?

A. Yes, sir.

X-Q. 31. Isn't it a fact the sample you gave us was out of a bottle about one-sixth or one-eighth the size of that?

A. I never gave you a sample out of Dr. Phillips' bottle. Probably out of a bottle like that.

X-Q. 32. Do you know out of what bottle you did give us the sample?

A. No, I do not.

X-Q. 33. Then you do not know whether we got a sample at all of the stuff that Dr. Phillips used, do you?

A. I do not know; no, sir.

RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 34. You—Who handled the sample to the representative of the Minerals Separation if you know?

A. I do not know.

MR. GARRISON: Now, if your honor please, we move to strike out Dr. Sadtler's testimony respecting this kerosene. It rests upon absolutely no proof whatever that it was the material.

THE COURT: It would depend upon tracing it up through the testimony of so many witnesses that the court would not be prepared to say that the sample is not identified or that it is identified. At the present

time the motion will be denied. If the sample is not similar to that used in the test of course the court will disregard the testimony in relation to it. The exception will be noted.

MR. GARRISON: In view of your honor's undertaking to trace it up I do not know that I want any exception. That is the reason I did not crave one.

BEN H. DOSENBACH, Recalled in sur-rebuttal, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

THE COURT: I want to say right now, if there is any tracing to be done, and if either party on either side expect any value from it, I will expect them to do the tracing, both sides. You may proceed, Mr. Scott.

Q. 1. MR. SCOTT: Mr. Dosenbach, do you agree with the statement advanced by Dr. Grosvenor in connection with the moving pictures that particles oiled with sufficient oil to cause them to adhere together will not adhere to an air bubble?

A. I do not agree with the doctor.

MR. GARRISON: I object to that. How can this be sur-rebuttal testimony? I respectfully submit it is not in any aspect of the case.

MR. SCOTT: There is a theory brought forward the first time upon rebuttal, something that was never

injected into this case before, the whole theory of these moving pictures.

THE COURT: Please read the question.

Q. 2. (Question read as follows: "Mr. Dosenbach, do you agree with the statement advanced by Dr. Grosvenor in connection with the moving pictures, that particles oiled with sufficient oil to cause them to adhere together, will not adhere to an air bubble?")

THE COURT: Well, Mr. Scott, what have you to say?

MR. SCOTT: My point is that this is an entirely new aspect of the case introduced for the first time in rebuttal, this proposition that particles oiled with sufficient oil to adhere together will not adhere to an air bubble. It is an entirely new angle of the case injected for the first time in rebuttal.

MR. WILLIAMS: Mr. Scott, didn't you ask that question of Prof. Bancroft by way of anticipation of the moving pitcures?

MR. SCOTT: I don't recollect it.

MR. WILLIAMS: I recollect quite distinctly that you put that question to Prof. Bancroft.

MR. SCOTT: Well, if you will produce it. I can't remember really, in the course of this trial.

THE COURT: Very well, let him answer the question, the objection will be overruled. He has answered.

Q. 3. MR. SCOTT: Can you corroborate your statement by actually lifting such a particle with an air bubble?

Ben H. Dosenbach.

A. I can.

Q. 4. Will you do so?

A. Yes.

MR. GARRISON: Now, if your honor pleases, we think this is not sur-rebuttal at all.

THE COURT: Oh, it might be. If this is material introduced by Dr. Grosvenor as a new experiment I think they would have a right to show whether it would do so.

~~A. Yes.~~

MR. GARRISON: Yes, I agree with you on that.

THE COURT: If it is a new matter, a new matter brought out— It is called sur-rebuttal, it is simply their rebuttal of material of yours.

MR. GARRISON: Your honor and I agree entirely upon the principle. The question is whether the case meets the principle. My idea is that they have gone over this matter with their professional witnesses —and by that I do not mean any disrespect. I mean their expert witnesses. And these experts said what they had to say about it. Dr. Grosvenor said what he had to say about it, and if they feel that our people have infringed upon the work of their testimony, they certainly can not now come and offer cumulative testimony.

THE COURT: No, the case is not to be tried over again, but there seems to be a difference whether this was gone into in the former testimony.

MR. GARRISON: I think we can show that they went over this with Prof. Bancroft.

THE COURT: Let's see it.

MR. WILLIAMS: And then the other point is that the statement has not been correctly quoted; that Dr. Grosvenor did not say that lifting was impossible under those conditions.

THE COURT: Well, let us see what the testimony is; hadn't you better find it.

(Short recess was taken).

THE COURT: What is it you say that Dr. Grosvenor testified?

MR. SCOTT: I cannot quote his exact language, but it was to the effect that the particles of matter, if sufficiently oiled to adhere together, would not adhere to air bubbles; that is if we had an aggregation of particles sticking together by the adhesion of the oil, that that aggregation would not stick on to an air bubble, and Dr. Grosvenor illustrated that with particles of appreciable size, little discs of aluminum, and regardless of whether the comparison was touched on by Prof. Bancroft or not, which I cannot remember, in view of the fact that Dr. Grosvenor illustrated this in the moving pictures and also on the court's desk with large particles of aluminum, without any reference to flotation, my purpose was to show that particles of the size which are actually dealt with in flotation, when particles of that size are used that they do adhere, regardless of whether they are oiled or not, whether they have oil enough to adhere together or not, and I propose to have Mr. Dosenbach repeat this with Cattermole granules, which are agglomerations of

particles held together by the adhesiveness of the oils upon them. My object is to show that. To show that particles a thousand times as heavy as the air bubbles will not stick to them is absolutely without probative force, and is only calculated to be misleading to the mind, because we do not claim that these forces are infinite and will lift anything, but we do claim that within the sphere of flotation, that the quantity of oil on the particles is absolutely immaterial.

THE COURT: Repeat your question.

Q. Do you agree with the statement made by Dr. Grosvenor to the effect that particles oiled with sufficient oil to cause them to adhere together, will not adhere to an air bubble?

A. I do not agree with Dr. Grosvenor.

MR. GARRISON: Wait a minute. In the first place, I think we are entitled to have what Dr. Gorsvenor said quoted. I don't think it is fair to summarize it this way.

MR. SCOTT: I will reframe the question.

THE COURT: You cannot always go back to the record and quote the exact language; it can be quoted in substance. Suppose the record were not printed.

MR. WILLIAMS: We claim that he does not give it in substance.

THE COURT: Well, look it up and see. If it is not practically correctly stated, he should reframe his question.

MR. WILLIAMS: I will briefly outline what Dr. Grosvenor did say for the purpose of showing that

Ben H. Dosenbach.

Mr. Scott did not state what Dr. Grosvenor said. Dr. Grosvenor started in with his first series, scene one, and gave the six milligram weight as the maximum lift which could be made with a captive bubble manipulated as gently as possible, with an amount of oil materially in excess of that required by the Cattermole process; that is to say, he started with the proposition that the maximum lifting power of a comparatively lightly oiled metallic particle was 6 mg. He took the maximum weight and he said that it was the maximum weight, and by that, of course, he necessarily said that if you get a lighter particle and you have it oiled, it certainly would be lifted. Now, this witness proposes to take the time of the court in corroborating the statement of Dr. Grosvenor that if a particle weighs six milligrams or less and it is oiled, the air bubble will lift it, and that is all there is in this question.

I speak of this with some knowledge, because at the Miami trial a whole day of the court's time was wasted with this sort of corroboration, alleged to be contradiction. It seems to me that it is perfectly foolish to go into it. Dr. Grosvenor has said that six milligrams is the maximum lift of an oiled particle, and this witness is going to show that you can take less than six milligrams and lift it. He can take little oiled particles, light particles such as are present in flotation, and lift them. Dr. Grosvenor said he could. What is the use of giving the time of the court to such corroborations which show absolutely nothing and indicate noth-

Ben H. Dosenbach.

ing of power or anything else, when it is nothing else, essentially, but a corroboration of the scientific investigation of Dr. Grosvenor.

MR. GARRISON: Now, from the other angle, if your honor please, on page 1111 of the direct examination of Dr. Bancroft, the question was asked him by Mr. Scott:

"Q. 121. Does it seem probable that one might draw a conclusion that air bubbles do not attach themselves to metallic particles coated with sufficient oil to produce adhesion?"

That is the exact question, practically, asked of this witness, and Dr. Bancroft answered as follows:

"A. If you are working with a sufficiently large particle, that would be the natural conclusion to draw from the experimental evidence, if you did not analyze it, but it would be an inaccurate conclusion for the simple reason that it it sot so.

"Q. What would be the more accurate way of putting it?"

And then Dr. Bancroft begins and answers for the rest of that page and part of the next page, and then Mr. Scott asked him to give some illustration of the matter and he answers again for a page and three quarters. Mr. Scott brought this matter in and asked his own witness, and got the witness to say just what he wanted him to say, or at all events what he did say, and we got Dr. Grosvenor to say what he said, and what he said makes no difference. He cannot now

bring in another witness to go over this field again that he brought into the case himself.

MR. WILLIAMS: Following that statements, the particular titles to which it is directed are as follows:

"AIR BUBBLES DO NOT READILY ATTACH THEMSELVES TO OIL GLOBULES AND HAVE SLIGHT, IF ANY, LIFTING POWER WHEN ATTACHED.

"AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL TO PRODUCE ADHESIVENESS."

Now, in connection with that title, Dr. Grosvenor gave a very full explanation. He said that he used the words "air bubbles do not attach themselves to metallic particles," for the reason that the air bubbles attach themselves to the oil coating of the metallic particles, and that was the meaning and intent, and that it was not intended in any manner to say that if oil coated particles were of sufficiently light weight, that air bubbles could not be made to make ~~n~~ an attachment of the oil on the oil coating of the particle to the oil lining of the bubble, and that there would be a lifting power, less than that of six milligrams. That explanation—I think it has not been read to the court, and I think it would perhaps be well to read it, as follows, from page 2534 of the record.

"Since we have seen that there is some amount of oil which will prevent direct attachment of mineral to

Ben H. Dosenbach.

the bubble, we are called upon to seek some indication of the line of demarkation at which the mineral ceases to become indirectly attached and becomes directly attached to the bubble film. A little thought, a moment's consideration, will convince one that if there is sufficient oil on the mineral to serve as a medium of attachment to another particle of mineral, there should be sufficient oil to serve as a medium of indirect attachment to an air bubble. A minute quantity of the oil will be required to supply the air bubble with its film, but even though the air bubble is 100 times the diameter of the particle and, therefore, possesses, ten thousand times the surface, the thickness of the film required by the bubble is only ten one-hundred-millionths, or sufficient to alter the thickness of the layer on the particle by about ten one-hundred-thousandths of an inch in thickness. For this rough comparison it makes no difference that the bubble is spherical and the particle is a cube. If the particle starts with a film about thirty-one-thousandths thick (Cattermole proportions) it will still have left enough oil for coating the bubble to furnish it with a layer twenty one-hundred-thousandths thick, or twenty thousand one-hundred-millionths or two thousand times as thick as the oil film on the surface of the bubble. So that it is important to observe whether under these conditions the drawing of the oil together (i. e. the reduction of the film on the particle from the remaining twenty one-hundred-thousandths to the adsorption layer) will furnish enough excess oil with that held to the upper sur-

face of the mineral by adsorption and that on the bubble, to produce an intermediate layer of oil between the mineral and the bubble, capable of necking off and producing indirect weak attachment.

"Again we shall compare the unoiled aluminum disc with the two oiled aluminum particles; the former weighing fifty milligrams and each of the latter being about 25 mgs. The two latter, however, have been oiled with cottonseed oil, specific gravity .92 and weighing .26 milligrams, about nine-tenths per cent of the weight of the aluminum particle, and producing a layer of oil about thirty one-hundred thousands of an inch thick on the surface of the aluminum. This layer on the surface of a material ground to 80 mesh will require between 4 per cent and 8 per cent of oil on the mineral by weight. It is seen that the air bubble peels off from the surface of the particle after substantial attachment, and careful examination of the pictures, highly magnified shows that there is distinctly something between the air bubble and the mineral particle. That this amount of oil is sufficient to produce adhesiveness we will show by the ability to pick up one oiled particle with the other, and the excellent degree of adhesiveness that rsults."

Now, the whole purpose and intent of that title is that this is an experiment in which the air bubble is not directly attached to the metallic particle because there is enough oil there to produce an attachment of oil to oil.

THE COURT: Your understanding is that Dr.

Grosvenor did not say that two oiled particles which adhere together could not be lifted by the air bubble?

MR. WILLIAMS: Not for a moment.

MR. SCOTT: The moving picture bore that label in the biggest letters that could be displayed on the screen, and I think the indirect nature of the photograph and of the explanation read by counsel which was given by the witness, are full justification for the claim that this thing is left in obscurity. As I had forgotten, Professor Bancroft stated that particles oiled with sufficient oil to adhere together would adhere to an air bubble unless they were too large. He said they would adhere unless they were simply beyond the range of the forces involved. Then Dr. Grosvenor in a manner that is not at all clear to me put forth his unqualified proposition that air bubbles do not attach themselves to metallic particles coated with sufficient oil to produce adhesiveness, and he illustrates it to this court by using particles so large that they are very apt to cause misunderstanding.

THE COURT: Suppose we take his testimony on your construction for the sake of argument, then you are simply disputing a square issue between himself and Prof. Bancroft.

MR. SCOTT: He has illustrated his side of the controversy by exhibiting to the court the inability of the bubble to lift particles which are so heavy that it would be absurd to be expected them to be lifted, and that might lead to a false impression.

THE COURT: No, no, I think we are guarded

against that; I think we can take his testimony at its own value. Prof. Bancroft testified to one state of facts about it, as was proper in your case, and in contradiction of that Dr. Grosvenor has testified to another state of facts, that is, he simply has denied it, and the matter rests there. If I allow this witness now to show an experiment before the court, it would simply be repeating what Prof. Bancroft said. I am inclined to repudiate such a construction of Dr. Grosvenor's testimony.

MR. SCOTT: Well, that puts a different face on it.

THE COURT: Objection sustained.

Plaintiff excepted.

WHEREUPON an adjournment was taken until 2:00 p. m. May 15, 1917.

Tuesday, May 15, 1917, 2:00 P. M.

JAMES WALTER DUDGEON, Recalled, testified, as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 22. Mr. Dudgeon, just before recess this question was put to you: "And some kerosene from one of those bottles which we have assumed to be five, was that given to Dr. Sadtler?" To which you answered "Yes." The next question, "And some of this same

James Walter Dudgeon.

kerosene you testified was the kerosene that Dr. Phillips used, is that correct? A. I have no knowledge of what Dr. Phillips used, as I was not present when he made his experiment." What experiment did you refer to there?

A. The experiment at the laboratory at the time he was taking the pictures.

Q. 23. Were you present during any experiment that he made?

A. I was.

Q. 24. What experiment was that?

A. The experiment with the bar mixer in court.

Q. 25. You were here personally and saw that experiment?

A. Yes.

Q. 26. It was assumed this morning that you meant that it was five bottles from the laboratory of the Butte & Superior mill; was it in fact five bottles?

A. It was.

Q. 27. Tell us what became of those bottles?

A. One of those five bottles was kept in the laboratory for a reference sample, and the other four were brought to the Federal Building and placed in our laboratory in the jury room on the third floor.

Q. 28. What was the description?

A. Kerosene A; 4-16-17.

Q. 29. That was put on a label was it?

A. It was.

Q. 30. On each of the bottles?

A. On each of the bottles.

James Walter Dudgeon.

Q. 31. Who brought the four bottles to the laboratory in the post office building?

A. Well, they came with the rest of the laboratory equipment from the plant in a wagon.

Q. 32. Who had charge of the transportation of them from the mill laboratory to the post office?

A. Mr. Hackwood was directly in charge.

Q. 33. Now, you were present when Mr. Phillips performed the experiment in the court room. Did you see what oil he used?

A. Yes.

Q. 34. Did you see what kind of container it was taken from?

A. I did.

Q. 35. What was that container?

A. It was a small eight ounce bottle.

Q. 36. Who took the kerosene from that bottle for the experiment which Dr. Phillips performed?

A. Dr. Phillips himself.

Q. 37. You saw him do it?

A. I did.

Q. 38. Did you yourself have occasion to take any kerosene from that bottle?

A. I did.

Q. 39. And what was the occasion of your taking kerosene from that botle?

A. In order to give the Minerals Separation representative a sample of the kerosene.

Q. 40. Did you give them a sample?

A. I did.

James Walter Dudgeon.

Q. 41. Do you know which of their representatives it was?

A. As I remember, it was Mr. Chapman.

Q. 42. And you say that was taken from the same bottle that Dr. Phillips took his from for the experiment?

A. It was.

Q. 43. I think you testified this morning that you gave Dr. Sadtler a sample of kerosene from the one large bottle which was left at the mill?

A. I did.

Q. 44. And in doing so did you take any precaution to see that you were taking it from one bottle of the five which you had drawn of kerosene A?

A. I did, by looking at the tag which I had placed thereon the day I drew the samples from the container.

Q. 45. What do you know about this small bottle —I think you referred to it as an eight ounce bottle— that Mr. Phillips took the kerosene from for his experiment—and that you poured a sample from for the representative of Minerals Separation, Limited?

A. Before that experiment was performed in court, Mr. Hackwood and I segregated the necessary equipment to perform that experiment, and this bottle of kerosene was placed in the box along with the other equipment and brought to the court room.

Q. 46. Where was it taken from to put it in the box to be brought to the court room?

A. From the equipment that Mr. Phillips had in doing his experiments.

Q. 47. And that is the extent of your knowledge of the small bottle of kerosene?

A. Yes.

CROSS EXAMINATION

BY MR. GARRISON:

X-Q. 48. The sample of the oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?

A. I have previously said that I had no knowledge of the kerosene with which Mr. Phillips did his experiment in the laboratory for the pictures.

MR. GARRISON: Read the question.

X-Q. 49. (Question read as follows: "The sample of the oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?")

A. That is correct.

X-Q. 50. And what personal knowledge have you of where the contents of that eight ounce bottle came from immediately before they got into the eight ounce bottle?

A. As I have stated twice before, I have no knowledge of where that bottle that Dr. Phillips used in his

James Walter Dudgeon.

experiment in the laboratory in producing the pictures, came from.

X-Q. 51. I am not asking you a word, sir, about producing the pictures. I am asking you about the experiment that you say you saw. I am going to entirely confine my question to that, so this question is directed to the experiment which you say you saw. Now read the witness the question with that explanation.

X-Q. 52. (Question read as follows: "The sample of oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?" "And what personal knowledge have you of where the contents of that eight ounce bottle came from immediately before they got into the eight ounce bottle?")

A. I have no knowledge of where that sample came from directly before it was put into the eight ounce bottle.

MR. GARRISON: That is all.

(WITNESS EXCUSED).

ARTHUR WELLSLEY HACKWOOD, recalled testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 35. You testified this morning that you saw Mr. Dudgeon I think, and directed him to draw several bottles of kerosene "A" from the container at the laboratory of the Butte & Superior mill. It was assumed there were five bottles. Do you know what is the fact as to how many bottles there were so drawn?

A. It was five.

Q. 36. And were they identified in any way?

A. They were all marked and labeled with the date that they were drawn.

Q. 37. And who marked them, Mr. Dudgeon or you?

A. Mr. Dudgeon marked them.

Q. 38. And what became of those bottles?

A. Four bottles were brought down to the laboratory here in the Federal Building, and one bottle was kept at the plant.

Q. 39. And who brought them, or in whose charge were they brought?

A. They were in my charge.

Q. 40. Have you any knowledge that the bottles that were finally delivered here were the same bottles that Mr. Dudgeon drew?

A. They were.

Arthur Wellsley Hackwood

Q. 41. Were you present in the court room when Mr. Phillips performed the experiment with the bar mixer, I think, with 25% of kerosene?

A. I was.

Q. 43. What kerosene did he use?

A. Out of the same bottle that I furnished him upstairs to perform his experiment with.

Q. 44. And what bottle was that that you furnished him upstairs to perform his experiment with?

A. A small eight ounce bottle.

Q. 45. And who filled that small eight ou. bottle, and what was it filled from?

A. I filled it. I filled it from one of the bottles I brought from the plant.

Q. 46. Of the kerosene "A"?

A. Of the same kerosene.

Q. 47. And it was from this eight ounce bottle that Mr. Phillips used the kerosene for his experiment, you say?

A. Here in court, it was.

Q. 48. Who brought that eight ounce bottle down from the laboratory?

A. I did.

Q. 49. And did you see Mr. Phillips perform his experiment?

A. I did.

Q. 50. Did you see him pour the oil or the kerosene into the mixer?

A. Yes.

Arthur Wellsley Hackwood

Q. 51. Was there any marking to your knowledge on the small eight ounce bottle of kerosene?

A. Why, yes, it was marked "kerosene."

Q. 52. And who did that?

A. I did when I filled the bottle; I marked it "kerosene."

Q. 53. Was there any other kerosene around the Post Office laboratory at that time?

A. Kerosene—The other bottles of that—from the same container, representative samples.

Q. 54. No other kerosene except this kerosene "A," that you brought down in the four bottles?

A. No.

Q. 55. Is that bottle still in existence, this eight ounce bottle bearing that marking?

A. Yes, it is here.

Q. 56. Have you it with you?

A. No, I haven't got it; I can send up and get it. It is in the same box. Mr. Dudgeon can get it.

Q. 57. What about the eight ounce bottle; where has that eight ounce bottle been since Mr. Phillips used it?

A. It has been in the laboratory all the time since we took the stuff back upstairs after he finished his experiment.

MR. SCOTT: You may cross examine while we are waiting for the bottle.

MR. GARRISON: Do you want to put the bottle in?

Arthur Wellsley Hackwood

MR. SCOTT: I will just produce it; I don't think there is any use in putting it in.

CROSS EXAMINATION.

BY MR. GARRISON:

X-Q. 58. Now, Mr. Hackwood, how long before Mr. Phillips did his experiment in the court had you brought these four bottles that you speak of, to the Federal Building?

A. The bottles were brought from the plant on April 16th. As to the date—the exact date the experiments were performed in court, I don't remember.

X-Q. 59. I think it was about the 24th that Mr. Phillips testified.

A. Yes.

X-Q. 60. What was the size of these bottles?

A. That we brought from the plant?

X-Q. 61. Yes.

A. They were two litre bottles.

X-Q. 62. And all the five bottles were two litre bottles, were they?

A. Two litre bottles; but only four of them that were brought to the Federal building.

X-Q. 63. There were five initially?

A. Five initial bottles.

X-Q. 64. And four you brought here?

A. Yes.

X-Q. 65. And these were four two litre bottles?

A. Four two litre bottles.

Arthur Wellsley Hackwood

X-Q. 66. And, at the time that Mr. Phillips did that experiment the other three bottles were full were they, and the other bottle out of which you poured the eight ounce contents was full except what you had poured out; is that correct?

A. Why, we have run the experimental tests over, the experiments we performed for the court, out of these bottles in the laboratory. Outside of that they were just the same.

X-Q. 67. That is, they had in them whatever they actually had had in them excepting what you had taken out to do experiments with, is that correct?

A. Yes, sir.

X-Q. 68. Now, do you know anything about the kerosene oil that was furnished to Dr. Sadtler, personally?

A. At the plant?

X-Q. 69. Read the witness the question. I mean the kerosene oil that Dr. Sadtler testified that he got and which he analyzed?

A. I was not present when he got it.

X-Q. 70. So you don't know anything about it?

A. No, I don't know anything about it.

RE-DIRECT EXAMINATION.

BY MR. SCOTT:

R-Q. 71. Is this the eight ounce bottle you refer to?

A. That is the same bottle, yes, sir.

R-Q. 72. Did you say you marked that bottle?

Arthur Wellsley Hackwood

A. I marked the label, yes, sir.

R-Q. 73. Do you know, as a matter of fact whether that bottle was—contains the same oil that was left in it when—after Dr. Phillips performed his experiment and after Mr. Dudgeon gave the sample to the Minerals Separation representative?

A. It should be.

R-Q. 74. You don't have any knowledge of its being changed?

A. No knowledge of its being changed. There was only the three keys to the room and no one got in there that I know of.

MR. SCOTT: That is all.

WITNESS EXCUSED.

MR. SCOTT: Our case will be closed with the exception of some reports of assays of demonstrations which I submitted to Mr. Williams this morning and in regard to which I have not heard from him as to his wishes.

MR. WILLIAMS: If you will strike that out, and strike that out, I will admit it.

MR. GARRISON: The defendant desires me to stipulate and I do so, that the sample of the kerosene oil used by Dr. Phillips was furnished to Mr. Chapman, as the witness says it was.

MR. SCOTT: I offer in evidence report of operations of the miniature flotation plant that was exhibited

to the court in the grand jury room. The parts that I have marked off are taken off by stipulation.

The report was admitted in evidence marked DEFENDANT'S EXHIBIT 302.

MR. SCOTT: And I offer in evidence a report giving a screen analysis of the material treated at the Butte & Superior mill on April 29th, 1917, being upon the occasion of the inspection of the mill by the representatives of the Minerals Separation, Limited.

Said report of screen analysis was admitted in evidence marked DEFENDANT'S EXHIBIT No. 303.

MR. SCOTT: I offer in evidence report of the assay results of several tests performed by Mr. B. H. Dosenbach, the tests being designated, Everson test No. 30, Everson test 31, Kirby test No. 32, Butte & Superior alternate Cattermole and patent in suit, Test No. 33; Butte & Superior test No. 36.

Said report of assay results admitted in evidence marked DEFENDANT'S EXHIBIT No. 304.

MR. SCOTT: I offer in evidence a report entitled the result of the experiments performed in court as testified to by B. H. Dosenbach, test No. 34. This is a test in the Janney flotation machine.

Said report admitted in evidence marked DEFENDANT'S EXHIBIT No. 305.

MR. SCOTT: I offer in evidence three photographs of the miniature flotation machine which was exhibited in the grand jury room.

Said photographs were admitted in evidence, and marked DEFENDANT'S EXHIBITS 306, 307 and 308 respectively.

MR. SCOTT: I would like the record to show that this bottle of oil is offered for inspection of the plaintiff, and will be offered in evidence if they so desire.

MR. GARRISON: I can see no relevancy in that offer. It is admitted that whatever Dr. Phillips used was furnished to us. The utmost that their witness has said was that it came out of this bottle. I see no reason why we should be burdened with the bottle as an exhibit.

THE COURT: There is nothing for the court to say.

MR. GARRISON: Well, I object.

MR. SCOTT: I offered it conditional on your requesting it.

MR. GARRISON: Well, I will relieve the court by stating that I don't request it.

THE COURT: Very well. Does that conclude the defendant's case?

MR. SCOTT: Defendant's case is concluded.

MR. KENYON: Before defendant's case is concluded I wish to offer an exhibit which is connected with defendant's case. Counsel asked plaintiff's ex-

pert witness, Mr. Wiggin, to produce certain tabulations and figures and I now produce them in his behalf, and he is in court to explain them if desired: namely: a copy from the daily records of the reagent consumption in the copper sand, copper slime, and zinc ore concentrators, for the months of January, February and March, 1917, in the Washoe plant; also copy from the same source of the daily records of the copper contents in the current mill slime, that being the only record the witness could get. Also three tables giving the aggregate or average reagent consumption and sulphide contents of the ore in the three concentrators for the months of January, February and March, 1917.

These are offered in evidence with consecutive exhibit numbers.

> Tables admitted in evidence and marked PLAINTIFF'S EXHIBITS 309, 310, 311, 312, 313, 314 and 315.

MR. SCOTT: There is one thing I forgot; I calculated to recall Mr. Wicks to show how a discrepancy arose on his figures. I would like to recall him now.

THE COURT: Very well.

Frank R. Wicks.

FRANK R. WICKS, recalled in behalf of the defendant in sur-rebuttal, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Wicks, have you examined plaintiff's exhibit 255, being a compilation of figures relating to the Chino Company?

A. Yes, sir.

Q. 2. Have you compared it with the report you produced, from which the figures are drawn?

A. Yes.

Q. 3. Now, I don't think you need put any further compilation of the matter in; if you will simply explain the relation of plaintiff's exhibit 255 to your compilation from which the figures were drawn, explaining their failure to check up, that will be all that is necessary.

A. All right. Now, referring to plaintiff's exhibit 255, particularly the last line, which is the data pertaining to the 18th, 19th and 20th of November, the average assay of the tailings as given on that line is .244, which is taken from exhibit 29. The calucula-tion shown on the column just preceding that, calculated tailings .489 I endeavored to check that, and in doing so I check back on each of the individual days on which those were made up, and following out the method followed by Mr. Wilding which I have designated as the M. S. method, I found that on the 18th

Frank R. Wicks.

the caluculated tailing would be .27 as compared with a tailing shown by the assay of .26. That .26 tailing may be found on the copy of the monthly statement that I presented as defendant's exhibit 230, which contains the detail from which exhibit 29 was made up. The calculated tailing, following the same method, for the 19th of November, would be .265, as compared with .29, contained in the regular sheet; and for the 20th it will be .14 calculated tailing, against .17 assay; so that the check all through there for those three days is remarkably close.

Then in checking back to endeavor to locate the discrepancy I found that the average concentrate assay as shown on exhibit 29 for November 18th, 19th and 20th, which is 29.28 per cent copper on exhibit 29—that a recalculation of that figure from the individual assays shown on exhibit 230 shows that that 29.28 should have been 29.78, evidently a typographical error. It appears very small, but yet it completely alters the calculation of the tailings shown by Mr. Wilding on his exhibit 255, and I do not see how he could have failed to find that if he had gone through these figures because he had my exhibit 230 before him several days before this was presented. But, any way, a recalculation of that tailing based on the correct concentrate assay shows that, following the M. S. method, that calculated tailing should be .233, as compared with an assay given in the following column of .244, which is remarkably close. Now, of course, changing that concentrate assay there from

Frank R. Wicks.

29.28 to 29.78 changes the recovery a little, but the change is only from 98.437 to 98.423, which is practically nothing. The change in the calculated assay, which Mr. Wilding has shown as 96.84, then becomes 98.49, which has to be compared with 98.42. Now, that takes care of that.

Now, in the case of this whole statement I should say that it shows that the concentrate shown under the heading of flotation concentrate ton on exhibit 255 prepared by Mr. Wilding, are not actual weights, and to verify that I would refer back to my testimony covering that matter, which is page 371 of the transcript, question 599. This refers to the methods of comparison between the actual dry weights and the theoretical amounts of concentrate produced by the various plants. I would also refer to page 346, question 474. I think that is the right number, but the book I took that from was not numbered and I am not exactly sure that that was the question. But on page 346, anyway, where I show that the concentrates were all mixed in the settling system before they were weighed, so it is necessary to take the theoretical amounts from the various plants as the actual figures, because there is no way of obtaining actual dry weights by the—of the individual flotation plants. Anyway, they are close enough for an average for the calculations that we have to make at the plant.

Now, there is just one other thing. Mr. Wilding by exhibit 255 made some calculations based on the cost of smelting the concentrate and the cost of con-

centration and so on, and he based that on the cost per ton. Now, the cost per ton for ordinary mill work is close enough for approximations of some things all the way, where the material considered is approximately of the same character throughout. But the cost per ton on comparisons of material that are quite unlike leads to erroneous conclusions. Wherever accurate work is necessary we always base our figures on the cost per pound of copper, because the copper is what we have to sell, and the cost per pound and what we get for it is really the most important thing about the plant. Recalculating the figures shown on exhibit 255 and basing it on the pounds of copper contained in the material treated, which after all is the most important thing, I have prepared another exhibit showing the pounds of copper in the tailing per pound of copper in the heads. I should refer to the loss of copper in the tailings per pound of copper in the head, about the middle of the exhibit. There is the calculation of the number of pounds of copper actually lost in the tailings per pound of copper in the heading, which is the unit that it is most important to figure on. And then in the column following that it is the value of that at twenty cents per pound, the price which Mr. Wilding assumed. Then I left the smelting charge as Mr. Wilding assumed it, at $6.00 per ton, and the total as he left it, and then I figured that in the cost of smelting per pound of copper in the headings. Then I calculated the cost of the oil and the cost of the reagent and added that to the

Frank R. Wicks.

value of the copper, and in the third column at the end I showed the total cost of oil, reagents and the value of the copper lost in the tailing, and all figured back per pound of copper in the feed, and I found that instead of the tremendous difference shown by Mr. Wilding in the column corresponding, that the figures are very nearly the same cost throughout, but what little difference there is is really in favor of the days on which we used the large quantities of oil. I think that completes the explanation.

Q. 4. You said, Mr. Wicks, that the weights were derived from the daily calculations by the foreman, did you not?

A. Yes.

Q. 5. Will you state how the assay figures are derived?

A. Well, the assays are actual assays of the samples taken for the day or rather for each of the three shifts for the day.

Q. 6. What I was trying to get at is is your assay applied to the concentrates made during the particular period that the assay covered?

A. Yes, sir.

Q. 7. That is, if you have an assay that you might call a composite assay, is that applied to the product of January 1st?

A. That is applied to the product of January 1st, yes.

Q. 8. For what purpose, for the purpose of finding the amount of the concentrate?

A. For determining the actual quality of the work that we are doing and from those assays to get the tonnage of the concentrate which is calculated in this case.

Q. 9. Referring to this tabulation which you have been looking at how do you get that figure "assay per cent copper," which is in the second column for the third quarter of 1916?

A. In the case of the third quarter of 1916 that is a calculated average for the 92 days of the quarter.

Q. 10. Just one composite assay applied to the whole period?

A. No, that is a calculation of the daily assays and they are averaged up geometrically.

Q. 11. And how about the tonnage, 6804 for the same period, the third quarter of 1916?

A. Well, that 6084 tons represents the arithmetical addition of the calculated quantities for each day. We have always recognized that that was not absolutely accurate, because of the calculation. For instance, if we take the average assays for the month and the calculated tonnage of concentrate from that, it does not always agree exactly with the arithmetical additions of the individual days, but saving confusion in our figures we always take the arithmetical addition of the individual days. This discrepancy is sometimes one way and sometimes the other, but it is not important in our work.

MR. SCOTT: I would like to offer this tabulation that the witness produced, entitled "Minerals

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Separation, Limited, vs. Butte & Superior Mining Company, referring to defendant's exhibit No. 29, Chino Copper Company, retreatment of vanner concentrates."

Said tabulation was admitted marked DEFENDANT'S EXHIBIT 316.

CROSS EXAMINATION,

BY MR. KENYON:

X-Q. 12. Referring to plaintiff's exhibit 255, is Mr. Wilding's figure correct in the third column of that exhibit for "Contents, Pounds of Copper in the Headings"?

A. Yes, sir, I find that correct.

X-Q. 13. You have made a correction in the sixth column headed, "Assay of Copper Flotation Concentrates," changing that figure in the last column from 29.28 to 29.78, as I understand you?

A. Yes, sir.

X-Q. 14. What change will that make in the next succeeding figure in that line, namely, "Contents, Pounds of Copper, Flotation Concentrates"?

A. That changes the pounds of copper in the concentrate from 111,264, shown by Mr. Wilding, to 113,164.

X-Q. 15. How will that change the figure under the heading "Tailings, contents pounds of copper, by difference"?

Frank R. Wicks.

A. Mr. Wilding shows 3629, and I get 1729.

X-Q. 16. By subtracting what from what?

A. By subtracting the figure shown in the third column from that shown in the seventh column.

X-Q. 17. And referring to the column "Loss of Copper in Tailings per ton of the Headings, Pound" and the last figure in that column what change will that require in that figure which is 6.47?

A. Well, I figured that back instead of in loss of copper per ton of heading, I figured it back in loss of copper per pound of copper in the heading.

X-Q. 18. Well, I asked you what change that would make in the figure 6.47, which indicates the loss of copper in tailings per ton in ton of heading?

A. That can be easily calculated.

X-Q. 19. Please do so.

A. That would be 3.08 instead of 6.47.

X-Q. 20. What change will be required in the next column, being the column "If One Pound of Copper in Concentrate be Worth 20 Cents Net to the Mill"?

A. You are referring to exhibit 255?

X-Q. 21. Yes.

A. That would be approximately .616.

X-Q. 22. What change, if any will be involved in the second column after that heading "Cost of Smelting Concentrate, Total"?

A. I left those figures just as Mr. Wilding showed them.

X-Q. 23. They are correct are they?

Frank R. Wicks.

A. I am not certain as to just what the smelting charge is, but Mr. Wilding assumed $6.00 per ton and I left it that way.

X-Q. 24. That is a fair amount?

A. I believe it is approximately right, but I am not sure as to the exact figure.

X-Q. 25. That is for hauling and treatment, is it?

A. That is what it is headed in this exhibit.

X-Q. 26. That is what you mean when you say it is a fair figure?

A. Yes, I believe it is approximately right.

X-Q. 27. Then what change will be required in the next two columns here, "Cost of Concentration per Ton of Heading"?

A. There will be no change in that per ton of headings in Mr. Wilding's statement.

X-Q. 28. But the second of those two columns?

A. To what are you referring now, "Cost of Concentrate"?

X-Q. 29. "Cost of Concentration" and the second column headed "Cost per ton of heading, including loss in tails and cost of smelting"?

A. Well, in those figures there, I simply excluded those figures from my calculation and recalculated on my basis of cost per ton of copper in headings because I believe that is more accurate.

X-Q. 30. Well, in this again, the only change required would be that the figure $1.294 should be changed to $.616, isn't it?

A. No. I went back and took the actual cost of oil from our statement, and applied that under the heading of cost of oil per pound copper in the headings, in exhibit 316. I failed to find that difference of 15 cents per ton increase in the cost of oil. There is an actual increase all right, but it don't figure quite that amount.

X-Q. 31. That figure 15, as explained by Mr. Wilding is not only the cost of oil, but the additional cost occasioned by the use of that additional oil. Is not that about a fair estimate per ton of heading?

A. Well, there is no additional cost due to the large quantity of oil other than the oil itself.

X-Q. 32. Isn't that a pretty fair estimate per ton of heading?

A. Well, I figure it to be about 6 cents as near as I can figure from these statements.

X-Q. 33. Won't you please consider that pretty carefully, as the discrepancy seems to be, to me, considerable? An estimate of 15 cents is given as a conservative estimate by Mr. Wilding.

A. Upon what did he base his figures? I can give you the total cost if you wish, and then we can figure it from that. The total cost of the oil for the three days, November 18th, 19th and 20th, was $506.21, which is 90 cents a ton. The total cost of oil, for October was $2615.00. Yes, that is 28 cents a ton. There is more difference there than I thought.

X-Q. 34. What is the additional cost of oil per ton of heading?

Frank R. Wicks.

A. In this case it would be the difference between 28 and 90 cents, 62 cents.

X-Q. 35. And the 62 cents per ton of headings is correct, instead of 15 cents per ton of heading?

A. Yes, in calculating I pointed out wrong.

X-Q. 36. Are you quite sure you are correct now?

A. I believe that is right.

X-Q. 37. THE COURT: Let me understand this exhibit 316. Total cost of oil per pound of copper in the heading, does it mean that on these three days your oil cost you nearly four and a half cents on the copper?

A. Nearly four and a half cents on the copper.

X-Q. 38. THE COURT: For every pound of copper?

A. For every pound of copper; unless these figures are wrong, and I believe they are right. That is typewritten wrong; that should be .00446. Mr. Scott, have you my original figures on that that I handed you with this exhibit? Well, then, that figure under "Cost of concentration, cost per pound of copper in the heading," the last line should be .00446.

X-Q. 39. Instead of .0446?

A. Yes. It does not affect the total shown in that second column from there.

X-Q. 40. Now, Mr. Wicks returning to plaintiff's exhibit 255 and to the double column headed "Cost of Concentration" in the last line, as I understand you, the figure 15 should be 62 in the first column, "A," plus 62, for the extra oil?

Frank R. Wicks.

A. I shall have to recalculate that now; yes, that is approximately right.

X-Q. 41. Now, in the second, the broad column there, the last entry should be A, plus 0.62, should it?

A. Well, that is a entirely erroneous column. It is absolutely unjust to figure on that basis at all.

X-Q. 42. Please answer the question.

A. I haven't calculated it.

X-Q. 43. That figure, which is intended to be a repetition of what is shown in the preceding column, you have corrected that to A plus 62, and the repetition should equally be A plus 62, should it not?

A. I have no doubt but what that is a proper figure.

X-Q. 44. Now, take the next figure, the next figure is 1.294 and was taken from the fifth preceding column. 1.294 which you have corrected to .616 now will make the correction of this column .616, the last figure, plus 2.032, was taken from the second preceding column which you have said was substantially correct. The addition there should be equally A plus —how much, as so corrected?

A. That would be A plus 3.268 instead of A plus 3.476.

X-Q. 45. I observe from the second column of that. of this exhibit 255, that the grade of the headings on that three days, November 18th, 19th and 20th, 1916, was distinctly higher than during the other two periods?

A. Yes, sir.

Frank R. Wicks.

X-Q. 46. Then that is to say there were more pounds of copper in each ton of heading that went to the mill?

A. Yes, sir—not that went to the mill—that went to this plant.

X-Q. 47. That went to the flotation plant. Therefore, when you divide the total cost of treating that tonnage by that large number of pounds in about the ratio of ten to seven you would get an apparent cost that was less, although the actual cost of treating the same tonnage would be more; is that correct?

A. Yes, sir; that is a little confused. May I ask you to state it another way?

X-Q. 48. You ask me to state it another way?

A. I don't understand it as you stated it.

X-Q. 49. Is the cost determined by the number of pounds of copper in the headings or by the number of tons of ore in the headings that you have to treat?

A. The cost is largely determined—largely dependent upon the number of pounds of copper in the headings, yes sir.

X-Q. 50. THE COURT: What does your oil cost ordinarily?

A. The two oils that we used there at that time cost us 32 cents a gallon for one and 5½ cents a gallon for the other.

X-Q. 51. THE COURT: Is it a mixture?

A. This is a mixture; yes, sir, and I gave Mr. Williams the exact number of pounds of oil that we used

on each of the days under discussion. I have the record here so that we can repeat it if you wish.

THE COURT: Not if they have it.

X-Q. 52. MR. KENYON: I can understand, Mr. Wicks, that for the purpose of determining profits it might be proper to divide the full cost by the number of pounds of copper in the heading, but for the purpose of comparing a metallurgical operation, the cost of treating your ore at different periods where the grade of the heading is varied, isn't it a fairer operation to consider it from the point of view of the tonnage of the headings?

A. No, I don't think so, Mr. Kenyon, because the material that contains the headings percentage of copper always costs us more money to treat.

X-Q. 53. Per ton of head, or per ton of copper?

A. No, per ton of headings in the copper, costs us more when there is more copper in the headings; in other words the cost varies more nearly directly as the assay of the heads, or the pounds of copper in the heads, than it does on the basis of the tonnage.

X-Q. 54. And is this an instance where the higher grade of the headings made the treatment cost you more?

A. Yes, the higher grade of the headings here required more oil, which of course added to the cost.

X-Q. 55. In the ratio of seven to ten?

A. Approximately, although not exactly, for perhaps the oil mixtures were not quite alike.

Frank R. Wicks.

X-Q. 56. In view of this difference that you have spoken of in the cost of treating the headings, that are higher in grade, as compared with the headings that are lower in grade, do you regard it as a proper comparison when you are comparing a metallurgical operation with another metallurgical operation to select periods where the headings were so distinctly and radically different as in this case?

A. Where the headings are radically different, it is the only method that I know that is accurate.

X-Q. 57. In these operations on these three days for every ton of heading that went into the flotation, 3.8 pounds of copper were lost as compared with 2.62, and 2.10 in the two earlier periods. That is correct, is it?

A. Yes, sir, that is correct.

WITNESS EXCUSED.

MR. SCOTT: I think our case is closed, now, your honor.

MR. WILLIAMS: I wish to offer in evidence table of the assays of the plaintiff as to the product obtained in the operation of the Butte & Superior miniature plant.

Said table of assays was admitted in evidence and marked PLAINTIFF'S EXHIBIT 317.

MR. WILLIAMS: I also offer in evidence a table

of assays as to the tests made in the course of the experiments made in court by Mr. Higgins.

Said table of assays was admitted marked

PLAINTIFF'S EXHIBIT 318.

MR. WILLIAMS: The usual stipulation applying to all these assays, that they are to be received in evidence with the same force and effect as if the witness who made the assays appeared and testified. Now, I have some photographs of pages of Ure's dictionary to offer in evidence and we will not be able to do that until tomorrow, but that is purely a matter of form.

THE COURT: This exhibit 316, do we understand Mr. Wicks to say that these oil mixtures were all the same those three days?

MR. SCOTT: I will have to ask, your honor.

MR. WICKS recalled, testified as follows:

DIRECT EXAMINATION.

BY MR. SCOTT:

Q. 58. THE COURT: I was asking if you had testified your oil mixtures were the same on this exhibit 316.

A. I gave Mr. Williams the oil mixture that was used on these individual days. I don't think that I gave him the exact oil mixtures that were used during the third quarter and during October.

Q. 59. Well, were they the same?

Frank R. Wicks.

A. They were the same oils, but the proportions of the different oils varied from time to time.

MR. KENYON: Can you give that to us now?

A. Yes, sir.

Q. 60. Please give that to us now, from the record.

MR. WICKES, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 61. What months are you giving for us now?

A. I have July and August and September, constituting the third quarter of 1916. Now, I haven't these figures totalled up; I have them for each individual day.

Q. 62. Well, read off some representative days?

A. How do you wish me to give them to you?

Q. 63. Well, start on the first of the month.

A. On the first of July we were using Lewis creosote and Jones—

Q. 64. MR. KENYON: Can't you tabulate that for us in some convenient way and then put it in afterwards?

THE COURT: All that the court wanted to know is—you were using a much cheaper mixture for those three days as I understand it?

THE WITNESS: Yes, sir. The Jones oil costs only five and a half cents a gallon, and the Barrett's No. 4 oil costs 32 cents a gallon, and then the propor-

tion of those two oils is changed from time to time back and forth, according to the conditions required in the plant. I notice back in July that we were using what is called the Lewis' creosote, but it is practically the same as the Barrett creosote: it comes from a different place, but it serves the same purpose.

THE COURT: I had only noted from his figures that it must be much cheaper, and I wanted to be sure.

MR. SCOTT: He can make a tabulation and present it afterwards.

THE COURT: Does that close the case, and are you ready for the argument?

MR. GARRISON: If your honor please, on behalf of both sides I desire to submit to your honor for your approval, if you do approve of it, the method in which counsel would like to dispose of this case. With your honor's permission we would like to adjourn now until tomorrow morning, so as to enable each side to have the intervening time to prepare their arguments, and we would then like, instead of having the 15 hours which we had previously agreed upon, being three court days of five hours each to dispose of the case in two days of six hours each, sitting from 10 to one and from two to five, and dividing those 12 hours equally between us. Does that meet with your honor's approval?

THE COURT: If both sides are agreed, it is satisfactory to the court.

MR. GARRISON: I desire to give notice to court

and counsel on the other side—at the time that we pressed the question of the effect of the Hyde decision upon this case, we had hoped that it could be segregated and decided without the necessity of going into the merits of the case. Our hope was—I am rather inclined to think it was never more than a pious hope—that we could get your honor to decide that point in the case separately, so that, if it was in our favor, we need not go into the other evidence, which would be otherwise necessary. Your honor, with entire propriety, it being entirely a matter of discretion, determined that it would be the proper way to have the entire case tried upon the merits, and your honor has reserved for final consideration the question of res adjudicata. We determined, under those circumstances, to abandon the point of res adjudicata, and have this case entirely decided upon the merits. I therefore now give notice to the other side that we abandon the charge of res adjudicata.

MR. KREMER: Thank you, Judge. That relieves me. I think the arguments may be considerably shortened.

THE COURT: Let the record show the statement of counsel.

MR. GARRISON: Yes, sir, it was made for that purpose.

THE COURT: You spoke once about desiring that the court should go out and look at these plants?

MR. SCOTT: Would it be agreeable to the court

to go? It would be agreeable to me to have the court go this afternoon.

THE COURT: Do you still desire it? Do you think it will aid us in arriving at a conclusion in this case? If you do, the court is willing to go.

MR. SCOTT: That is my state of mind, your honor. I really feel that we have talked so much about these matters and have shown little miniature plants to the court, that if the court has actually seen the operations I think it will be helpful.

MR. GARRISON: I would like to have your honor see the Timber Butte plant too. That is within easy automobiling distance. We will, of course, furnish cars. I suppose both sides ought to join in that so there will be no question about it.

MR. SCOTT: Certainly.

MR. GARRISON: It will not require but a very limited time to take them both in; it can be readily done in the course of the afternoon, before dinner time.

THE COURT: Very well. The court is willing to go.

WHEREUPON an adjournment was taken until Wednesday, May 16th, 1917, at 10:00 a. m.